Systematic studies in the eucalypts 7. A revision of the bloodwoods, genus *Corymbia* (Myrtaceae)

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Abstract

Hill, K.D. & Johnson, L.A.S. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1995. Systematic studies in the eucalypts. 7. A revision of the bloodwoods, genus Corymbia *(Myrtaceae). Telopea 6(2–3): 185–504.* A taxonomic revision of the bloodwoods (including 'ghost gums') is presented. Previous cladistic studies in the eucalypts are re-evaluated; new phylogenetic analyses are presented for the *Angophora* + *Eucalyptus* sens. lat. group, the *Angophora* + bloodwood clade, and the sections and series of the 'red bloodwoods'. The non-angophoroid, non-bloodwood eucalypts are discussed, but a formal taxonomic system for these is not presented here. The bloodwoods are placed in a new genus **Corymbia** K.D. Hill & L.A.S. Johnson. Relationships within the group are examined, and morphological interpretation and phytogeography are discussed. An infrageneric classification is presented, with keys to infrageneric groupings and species. One hundred and thirteen species are described, 33 of them new (**C. chlorolampra, C. maritima, C. ligans, C. plena, C. hendersonii, C. rubens, C. porphyritica, C. semiclara, C. tumescens, C. opacula, C. pedimontana, C. sphaerica, C. chartacea, C. dunlopiana, C. pachycarpa, C. papillosa, C. catenaria, C. paracolpica, C. arafurica, C. bella, C. disjuncta, C. pauciseta, C. karelgica, C. dendromerinx, C. torta, C. chillagoensis, C. inobvia, C. blakei, C. candida, C. punkapitiensis, C. aparrerinja, C. flavescens, C. paractia**). New subspecies are described or recognised in *C. trachyphloia* (subspp. **amphistomatica** and **carnarvonica**), *C. arnhemensis* (subsp. **monticola**), *C. hylandii* (subsp. **peninsularis**), *C. eremaea* (subsp. **oligocarpa**), *C. cadophora* (subsp. **pliantha**), *C. setosa* (subsp. **pedicellaris**), *C. ferruginea* (subsp. **stypophylla**), *C. pachycarpa* (subsp. **glabrescens**), *C. papillosa* (subsp. **globifera**), *C. deserticola* (subsp. **mesogeotica**), *C. torta* (subspp. **allanii** and **mixtifolia**), *C. blakei* (subsp. **rasilis**), *C. candida* (subspp. **dipsodes** and **lautifolia**), *C. ferriticola* (subsp. **sitiens**), *C. grandifolia* (subspp. **lamprocardia** and **longa**). A new name is provided for the species illegitimately known as *Eucalyptus perfoliata* (**C. cadophora**), and a valid publication of **C. aparrerinja** (published invalidly as a variety of *E. papuana* by Blakely) is effected. Two species are reinstated from synonymy (*C. polysciada* and *C. variegata*), and two raised from infraspecific to specific rank (**C. dallachiana** and **C. dimorpha**). Lectotypes are designated for the names *E. erythrophloia*, *E. bleeseri*, *E. zygophylla*, *E. perfoliata*, *E. erubescens*, *E. tessellaris* var. *dallachiana* and *E. aspera*, as well as neotypes for *E. calophylla* and *E. tessellaris*. Recently published names reduced to synonymy are: *E. erubescens* and *E. derbyensis* with *C. polycarpa*; *E. pontis* with *C. cliftoniana*; *E. hylandii* var. *campestris* with *C. hylandii* subsp. *hylandii*; *E. ollaris* with *C. umbonata*; *E. australis*, *E. symonii* and *E. connerensis* with *C. eremaea* subsp. *eremaea*; *E. nelsonii* and *E. fordeana* with *C. eremaea* subsp. *oligocarpa*; *E. centralis* and *E. orientalis* with *C. opaca*; *E. darwinensis* and *E. kakadu* with *C. foelscheana*; *E. durackiana* and *E. blackwelliana* with *C. dampieri*; *E. hesperis* and *E. bynoeana* with *C. hamersleyana*; *E. atrovirens* with *C. dichromophloia*; *E. serendipita* with *C. arnhemensis* subsp. *monticola*. The type of *E. coniophloia* is recognised as an intergrade and those of *E. tokwa* and *E. urnularis* as hybrids. New combinations are provided under *Corymbia* for 80 species and for one subspecies.

1. Introduction

1.1. General

The bloodwoods are a major component of the flora of northern Australia, and are significant components of woodland and forest floras in some more southern parts of the continent. The bloodwood group is readily recognisable by the combination of compound inflorescences, usually more or less urceolate fruits, which are often rather large, and bark fracturing or peeling in small polygonal scales to appear tessellated (except in *Corymbia jacobsiana*) when persistent. Most species occur in regions where, until recently, collections have been inadequate, and much confusion has surrounded species determination and nomenclature. This account presents the results of fifteen years of intensive study, including extensive field study. This followed several decades of more general acquaintance with the group by one of us (L.J.). We are both acquainted with almost all the taxa in the field.

1.2. Naming system

Names of sections, series and subseries used by us are intentionally published in a system devised by Pryor and Johnson (1971) and external to the International Code of Botanical Nomenclature. This avoids the confusion created by formal recognition of 'series' and 'subseries' that were used by Maiden (1903–1933) in a loose, informal sense, classifying according to particular organ sets rather than as taxa. Moreover, as explained previously by Pryor and Johnson (1971), it allows for clear application of names and categories. Since it has a perfectly clear formalism of its own, the term 'extracodical', rather than 'informal', is appropriate.

As in lists recently privately distributed to some eucalypt workers, subseries names here differ from those used by Pryor and Johnson in ending with '*-osae*'. This is because '*-inae*', previously used, is a subtribal ending (International Code of Botanical Nomenclature (ICBN), Greuter 1994, Art. 19.2).

The names applied to series and subseries by earlier authors are cited below merely to indicate the way in which those authors grouped the species concerned. Nothing is thereby implied about their standing, since we are using only our extracodical system between genus and species. Nevertheless, many of the series names taken up by Chippendale (1988) and subsequently used by some authors are appropriately interpreted as not validly published under the ICBN, having been used by Maiden not for taxa, but for reference to sets of species with certain characteristics in particular single organs.

For brevity, species authors are omitted from the introductory discussion, except for taxa that are not included in the taxonomic treatment.

1.3. Taxonomic history

The first bloodwood named was described by Gaertner in 1788 as *Metrosideros gummifera*. The same species was described again in *Eucalyptus* by J.E. Smith in 1793 as *E. corymbosa*. Several more species were described over the next 75 years, Schauer naming four in 1843, W.J. Hooker two in 1844 and 1848, and F. Mueller nine in 1859.

The bloodwoods were first recognised as a group (not then including 'ghost gums') by Bentham (1867), who divided the eucalypts into five series on the basis of anther morphology. He established the subseries *Corymbosae* in series *Normales*, including in it the 13 bloodwoods then maintained, and named three new taxa.

Mueller (1882, 1889) reduced Bentham's five series to three, placing the bloodwood species into the 'residual' series *Parallelantherae*. Between these two publications, he published an account wherein four series were recognised (1884), with series *Parallelantherae* divided into two series and the bloodwood species placed in the segregate series *Orthantherae*. This was again a residual group encompassing many diverse species. Mueller (1859) had earlier attempted to group the eucalypts according to bark structure, recognising six series that were quite discordant with his later anther-based series.

Maiden (Crit. Rev. Eucalyptus 6: 525–537, 1923) refined Bentham's anther-based classification, recognising six sections, but not clearly defining the status of his subdivisions. He recognised a group (≡ series) *Corymbosae* in subsection *Longiores* of section *Macrantherae*. He included most bloodwoods in the *Corymbosae*, together with *E. miniata* A. Cunn. ex Schauer and *E. phoenicea* F. Muell. (the latter two, both referred by us to *Eucalyptus (Leprolaena)*, in an anomalous unnamed subseries). He placed *E. ferruginea* in subsection *Tereticornes* of section *Macrantherae*. He later presented an alternative classification on the basis of seed morphology (Crit. Rev. Eucalyptus 7, 1925), with two 'series', *Terminaliptera* ('Winged Corymbosae'), and *Naviculares* ('Non-winged Corymbosae'). *E. ferruginea* was this time included in *Terminaliptera*. The 'ghost gums' were placed in a separate 'series' *Scutiformes*.

Maiden had earlier also divided the eucalypts according to timber (Crit. Revis. Eucalyptus 6: 128 et seq., 1922), recognising six groups. One group was 'bloodwoods', with all bloodwood taxa, including the ghost-gum group, but also including several other unrelated taxa.

Blakely (1934) recognised two series to include all bloodwood taxa, *Corymbosae* and *Corymbosae-Peltatae*, separated on juvenile leaf morphology. He included most of the ghost gums as a subseries *Tessellatae* in the former; these species had been placed in unrelated sections by both Bentham and Maiden. Other subseries that he recognised in the *Corymbosae* were *Ferrugineae* (including some ghost gums), *Gamophyllae*, *Eucorymbosae* and *Costatae*. The *Corymbosae-Peltatae* included subseries *Neocorymbosae*, *Ochrophloiae* and *Maculatae*. No regard was paid by Blakely to critical differences in seed morphology.

Blake (1953) separated the ghost gums as series *Clavigerae*, and included all other bloodwood taxa in series *Corymbosae*, with no further subdivisions. Pryor and Johnson (1971) recognised Blake's two series at the rank of subgenus (not formally described under the ICBN — see above) as *Blakella* and *Corymbia*. A comprehensive hierarchy of subordinate infrageneric taxa was also recognised, and this provides a basis for the classification presented here, with modification.

Carr and Carr (1988) presented an alternative informal subgeneric classification, somewhat resembling a simplified Pryor and Johnson system, but with different names.

Chippendale (1988) simplified the Pryor and Johnson classification in recognising one infrageneric rank only, consequently losing much of the information contained in the earlier hierarchical system. He placed the bloodwoods in seven series, one of which encompassed the ghost gums. All series correspond wholly with, and derive from, Pryor and Johnson taxa at some rank, but not uniformly with their series.

1.4. The present study

Many of the species occur in relatively inaccessible tropical regions, and herbarium collections have been inadequate for detailed comparative study until recently. Carr and Carr (1985, 1988) proposed many new species, but with limited collections and inadequate field study, often using single anatomical features to define them. The outcome has caused considerable confusion in bloodwood taxonomy and frustration among those who have tried to apply the names that Carr and Carr, as indicated by their specimen citation and maps, used for very mixed and overlapping concepts, with little evidence of field understanding or perception of natural populations and ecological patterns.

All the species that we recognise may be distinguished on relatively uncomplicated morphological character sets, although distinctions are frequently fine and based on character combinations rather than single characters. Ecological ranges also have been considered fully when evaluating taxa. Our specific concept does not call for species to be intersterile; such a criterion would lead to 'lumping' of many diverse and distinctive species (in our sense) that are consistent over large areas but have relatively limited zones of intergradation or interbreeding; moreover, it would leave no position in the hierarchy for subspecies as (eco)geographic components of species that differ to a lesser degree. In cases where a set of similar but distinctive species shows a geographic replacement pattern, and where some authors might treat them as subspecies, we have used the extracodical concept of superspecies (see Appendix 3).

We have studied almost all the species over all or most of their range in the field, and have carefully examined populations at type localities of ambiguous taxa proposed by others. The collections held by BRI, CANB and DNA have also been examined.

Our phylogenetic studies (see below, 1.5) indicate that the bloodwood groups are part of the *Angophora* clade, and clearly separate from the remainder of the eucalypts. Consequently, the bloodwoods are recognised here as a separate genus, *Corymbia*, which is quite clearly distinct from *Angophora* itself. We would stress once more that the English term 'eucalypts' (and its equivalents in other modern languages) should be used to include *all* of the complex discussed herein (perhaps with the exception of the *Arillastrum* group although, as indicated below, the monophyly of the non-*Arillastrum* eucalypts is not certain). Thus 'the eucalypts' are *Angophora* + *Corymbia* + *Eucalyptus* + any other genera that may be segregated; it is not an equivalent of the generic concept of *Eucalyptus* in any particular circumscription. The notion that angophoras are not eucalypts has lasted for far too long. Nevertheless, a statement recently made to us that all the eucalypts (including *Angophora*) should be united in one genus because such a grouping is (or was taken to be) monophyletic is naive — it could be argued on such a basis that the whole of the Myrtaceae, or the Anthophyta, or even all life, should be in one genus. There is more to useful taxonomy than recognition of clades, important as the latter point may be. We are convinced that recognition of the two genera *Angophora* and *Corymbia* separate from the remainder of the eucalypts is useful and informative.

1.5. Phylogeny

Published accounts of the phylogeny of the eucalypts differ considerably (Johnson & Briggs 1984, Ladiges & Humphries 1983). We have re-evaluated the characters used and also the conclusions reached in earlier studies, with some modification arising from data from our own observations. Additional data from other studies (emended where necessary) have been incorporated on characters defined by hair structures (Johnson 1972, Ladiges 1986), stigma morphology (Boland & Sedgely 1987), perianth morphology (Drinnan & Ladiges 1988, 1989a, b, c, 1991a, b; Williams 1981), wood and pith anatomy (Ingle & Dadswell 1953, Carr & Carr 1969), seed structure (Gauba & Pryor 1958, 1959, 1961), inflorescence structure (Briggs & Johnson 1979) and host relationship with psylloid (lerp) insects (Moore 1984, 1985, 1988).

Characters used in the analyses are listed and discussed in Appendix 2 where the date matrices are presented in Tables 1–4 (see also below, 1.9); the phylograms and cladograms derived are presented, and commented upon, in Figures 1–6. Our study indicates that *Corymbia* (the traditional 'bloodwoods' + the 'ghost gums') forms a robust clade together with *Angophora*. This clade (equivalent to the *Angophora* sub-alliance of Johnson & Briggs 1984) is monophyletic and characterised by the combination: highly developed tertiary venation, elongate bristle-glands, micropapillate oil-gland cap cells, presence of oxalate crystals in embryonic cotyledons, and the solitary vessels in the xylem. The *Corymbia* clade of bloodwoods + ghost gums (the latter being subgenus *Blakella* of Pryor & Johnson 1971, i.e. *Corymbia* section *Blakearia* of the present study) is in turn a monophyletic group characterised by the calyptrate calyx, unicellular hairs and the disjunct adult leaves. Similar character changes also occur in parallel in parts of the non-angophoroid eucalypt assemblage.

The (non-angophoroid) '*Eucalyptus*' group (appearing in our analyses as a single clade) is characterised (except possibly for '*Nothocalyptus*', '*Tingleria*' — not treated here — and one or both of the species of '*Gaubaea*') by the following: the regular arrangement of the ovules in vertical rows on the placenta, the petaline androecial buttress (which becomes the stemonophore), the development of the corolline calyptra from the dorsal or limb petal component only (with reduction of the ventral or keel component) (Drinnan & Ladiges 1989a, b, c, 1991a, b), the paired oil-gland cap cells, the presumably plesiomorphically isomerous perianth and gynoecium, and the emarginate cotyledons. This grouping comprises the constituents of the *Eucalyptus* and *Symphyomyrtus* suballiances of Johnson and Briggs (1984).

Recent studies of 5SrDNA spacer sequences (Udovicic et al. 1992 and in prep.) and chloroplast DNA sequences (Sale et al. 1993) corroborate the dichotomy between *Angophora* + *Corymbia* and the '*Eucalyptus*' group. The dichotomy between *Angophora* and *Corymbia* is also corroborated by those studies, as is the inclusion of '*Blakella*' near the yellow bloodwoods as a section *Blakearia* within *Corymbia*.

Our own long-term investigations and conclusions have been entirely independent of these macromolecular studies.[1]

1.6. Conclusions from phylogenetic study

1. The *Arillastrum* + *Angophora* + *Eucalyptus* group is well-defined and natural. This arises from Johnson & Briggs (1984), but is not contra-indicated by the present study.
2. The *Arillastrum* clade appears in some trees as the sister to an *Angophora* + 'eucalypt' group. However, equal-length alternatives would indicate the *Arillastrum* clade and the *Angophora* + *Corymbia* clade as sisters, and these together as sister to the

[1] While the present paper was in press, a publication (P.Y. Ladiges, F. Udovicic & A.N. Drinnan (1995). Eucalypt phylogeny — molecules and morphology. *Austral. Syst. Bot.* 8: 483–497) appeared, of which we had no prior knowledge. Its conclusions are similar to ours in most respects, but are based on considerably smaller taxon and character sets. The statement that 'informal subgenus *Corymbia* Pryor & Johnson is paraphyletic' refers to the concept held by Pryor and Johnson 24 years ago (i.e. excluding *Blakearia*). The study by Ladiges et al. in fact strongly supports the concept of *Corymbia* as defined in the present paper.

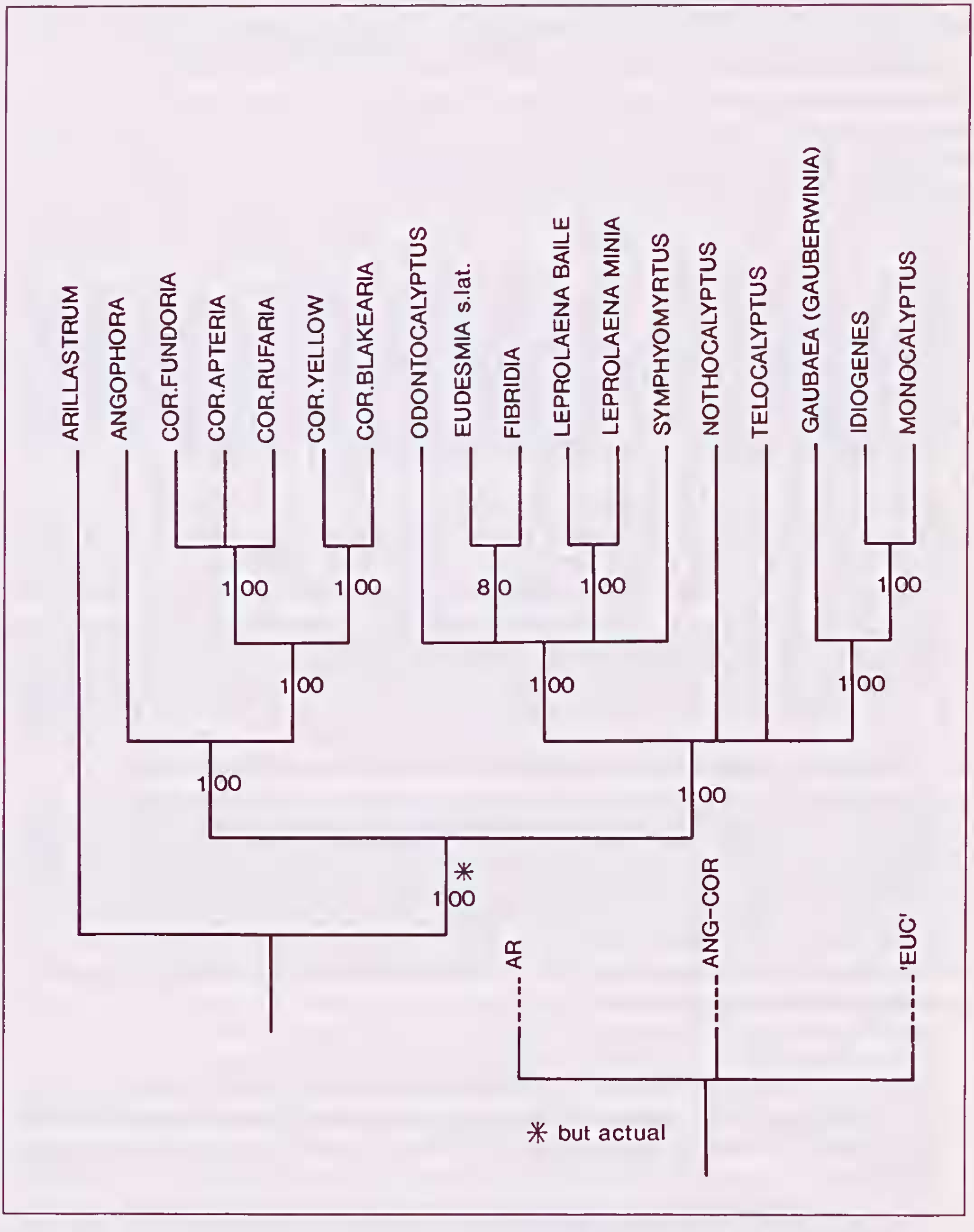

Fig. 1. Semistrict consensus cladogram as produced by PAUP of five shortest trees (from character-states as in Table 1b), using 'unordered' option, for the *Arillastrum* + 'eucalypt' complex. PAUP failed to produce five alternative trees of equal length that show a link at the second node (point *) between the *Arillastrum* group and the *Angophora* + *Corymbia* group (character transformations and length checked). Base of amended (correct) consensus tree allowing alternative is shown. Aspects of this cladogram are not considered to present a believable hypothesis because of reversals in the individual trees, variously, of characters 10, 17, 20 and others; see discussion of characters in Appendix 2, but note that many regions of the cladogram are robust and agree with those in Fig. 2.

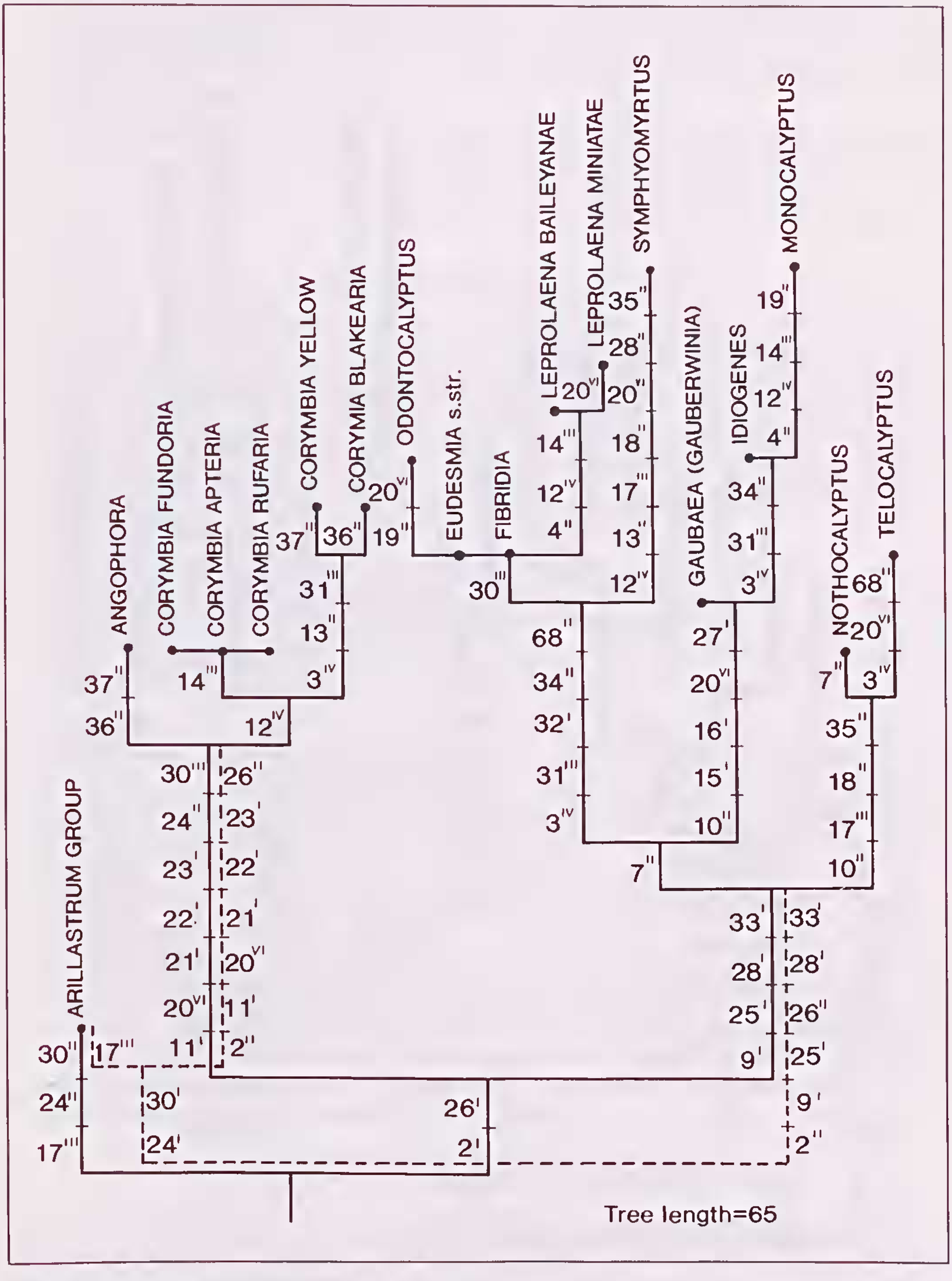

Fig. 2. Two shortest phylograms (identical except as shown by broken lines) from 12 produced using PAUP option constraining as irreversible the characters showing reversal in trees used for Fig. 1. The consensus (not shown) from this set differs from the amended version of Fig. 1 in showing the two components of *Leprolaena* as the only resolved clade internal to the *Eudesmia* s. lat. + *Symphyomyrtus* clade; it also shows lack of association of *Nothocalyptus* and *Telocalyptus*. Consideration of homoplasy and the discussion of characters supports these as justifiable uncertainties. Primes indicate number of occurrences of change in each character.

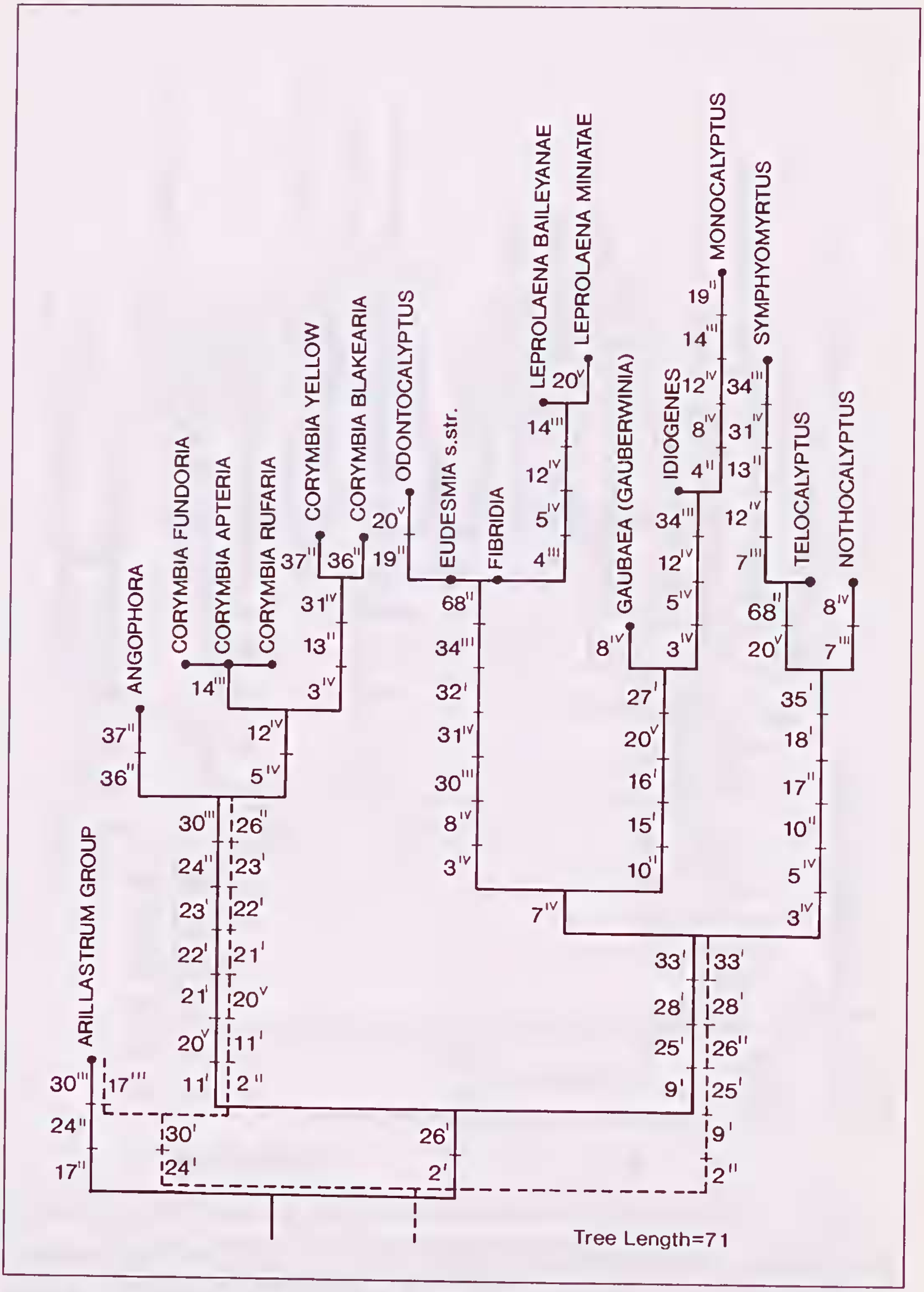

Fig. 3. Two shortest phylograms from four produced from character-states as in Table 1a using PAUP option of irreversibility as in Fig. 2. The association indicated only by the weak and homoplastic character 7 is insufficient to be convincing. The corresponding consensus cladogram (not shown) differs from that discussed under Fig. 2 in showing *Symphyomyrtus* as associating with *Telocalyptus* and these in turn with *Nothocalyptus*; this arises from unsatisfactorily defined characters omitted from, or rescored in, Table 1b (q.v.). Primes as in Fig. 2.

non-bloodwood eucalypts. A few additional, unscored characters may perhaps be adduced to support the first alternative, but these do not seem strong, and the second alternative still requires testing, especially by DNA analysis. An out-group external to the *Arillastrum* + 'eucalypt' complex will be necessary for such analysis, but has yet to be used.

3. A robust dichotomy separates the *Angophora* + *Corymbia* group from the remainder of the eucalypts (and another from the *Arillastrum* group).
4. The *Corymbia* (including *Blakearia*) clade is a robust monophyletic (holophyletic) group.
5. *Corymbia* would be paraphyletic if *Blakearia* were excluded.
6. *Eudesmia*, as sometimes treated (excluding the two components of *Gaubaea*), is a probably monophyletic complex of which the precise relationships with other non-bloodwood eucalypts are still somewhat uncertain, especially as to the position of *Symphyomyrtus*, i.e. at the base of the *Eudesmia* clade or elsewhere. We recognise four components within *Eudesmia* in this sense (*Eudesmia* s.str., '*Odontocalyptus*' ms., '*Fibridia*' ms. and '*Leprolaena*' ms.). Except for '*Odontocalyptus*', these manuscript names (status to be decided) were made known by us to eucalypt workers some years ago.
7. The '*Monocalyptus*' (*Eucalyptus* sensu stricto) clade, of which *Idiogenes* is an early sub-branch, is highly apomorphic, and appears in the analyses in several positions, as do *Symphyomyrtus*, *Telocalyptus* and *Nothocalyptus*, in relation to each other and to other clades. Further evaluation and study of some characters is necessary, again in relation to more macromolecular investigation.
8. The two possibly quite different components of *Gaubaea* ('*Gauberwinia*' = *E. curtisii* Blakely & C. White, and '*Heterogaubaea*' = *E. tenuipes*, (Maiden & Blakely) Blakely & C. White, the latter not included in our analyses for lack of some necessary data) need further consideration of their phylogenetic position; this also applies to *E. guilfoylei* Maiden ('*Tingleria*') and perhaps to *E. corynocalyx* F. Muell. ('*E. cladocalyx*' sphalm., '*Aenigmataria*'). We propose to deal with these in the future, but they do not affect the most important present conclusions (4 and 5) above.
9. Summarising 6, 7 and 8, recognition as a single genus of a coherent *Eucalyptus* 'sensu semilato' is not necessarily justified, especially in view of the uncertain position (and perhaps the interpretation of ovule and perianth-androecial characters) of *Nothocalyptus*, '*Tingleria*', *Gaubaea* (= '*Gauberwinia*' + '*Heterogaubaea*') and possibly of *Monocalyptus* (*Eucalyptus s. str.*) + *Idiogenes*. On the other hand, the subgenera recognised by Johnson and Briggs (1983, 1984) are, with a little modification, groups of unequivocal content.

1.7. *Blakearia* among the bloodwoods

A number of subgroups may be distinguished within *Corymbia* on the basis of various characters, especially seed and perianth morphology, although these characters show some homoplasy (as expected) and do not unequivocally resolve all the relationships (Figs 4–6). The subgroups are recognised as sections here, and larger sections are further divided into series and subseries. The ghost gums are definitely not separated as a sister from the (non-*Blakearia*) 'bloodwoods'; all of the trees (phylograms and consensus cladograms) of our analysis show the 'bloodwoods' as paraphyletic with respect to the ghost gums. We consequently recognise the ghost gums as a section (*Blakearia*) within *Corymbia*. In view of different conceptions in the past (Pryor & Johnson 1971; Johnson & Briggs 1983, 1984) and the present (see below), some discussion is required.

Blake (1953) was the first to differentiate and diagnose the ghost gums (as *Eucalyptus* series *Clavigerae*, in his inclusive circumscription). Brooker and Bean (1991) 'dissociate them totally' from the other bloodwoods, citing only Blake's distinctions as justification (see also Brooker & Kleinig 1994). In view of this stance, Blake's distinctions require more critical evaluation. Most of these distinctions are treated in the morphological discussions below, and will be summarised here. The seven differences cited are:

1. 'Inflorescences axillary, not terminal'. Axillary inflorescences also occur in section *Politaria*, and the basic inflorescence structure is shown to be homologous throughout the bloodwoods. Moreover, terminal inflorescences do occur 'flexibly' (Briggs & Johnson 1979) in some species of *Blakearia* series *Papuanae* (q.v.).
2. 'operculum thin and neatly circumsciss, not thick and irregularly or imperfectly circumsciss'. Blake himself (p. 230) observed that '*E. maculata*' (*C. maculata* and other species of *Politaria*) has 'sharply circumsciss opercula', and this condition of the calycine calyptra (≡ 'outer operculum') occurs also in sections *Ochraria* and *Cadagaria*.
3. 'flower with free part of calyx-tube saucer-shaped and much wider than the ovary, not more or less tubular'. The degree of distal expansion of the hypanthium in the flower varies in all bloodwood groups. While the ghost gums frequently have more expanded flowers than other groups, similar degrees of expansion can occur in any group.
4. 'ovary commonly 3-celled, not 4- or 5-celled'. Three–locular ovaries are also characteristic of sections *Ochraria*, *Politaria* and *Cadagaria*, and may well be the plesiomorphic state for *Corymbia* as a whole.
5. 'fruit with very thin walls and soon falling, not thick-walled and long-persistent'. Although the unthickened walls of the fruiting hypanthium do not occur elsewhere, all bloodwoods shed the seeds (and fruits) as soon as they mature. Long-persistent fruits occur only in some sections of *Eucalyptus* sensu semilato (i.e. excluding *Corymbia*), and the condition of shedding immediately upon maturity may be plesiomorphic in the eucalypts as a whole. The thin-walled and very quickly maturing fruits of the ghost gums appear to be autapomorphic for the group and, consequently, of no value in determining relationships.
6. 'seeds concavo-convex and without terminal wings, not biconvex and frequently with terminal wings'. Unwinged, dorsiventrally compressed and frequently concavo-convex seeds also occur in all bloodwood sections except *Rufaria* and appear to be the plesiomorphic state for the bloodwoods and *Augophora*.
7. 'venation of adult leaves less regular, with fewer lateral veins'. A similarly reduced venation occurs also in section *Cadagaria*. The degree of reduction of vein number is variable within the ghost gums also, and may be more or less neotenous.

Although relationships with other sections are not unequivocally resolved in this study, the ghost gums always group with the bloodwoods and cannot be dissociated therefrom. This association is also corroborated by analyses using the rbcL gene in chloroplast DNA (Sale et al. 1993) and the spacer region in the nuclear DNA coding for 5S ribosomal RNA (Udovicic et al. in prep.). Nonetheless, *Blakearia* is a very distinctive and easily recognised group, shown by the possession by its species of several synapomorphies. These are: the scarious calycine calyptra; the smooth bark shedding in very thin flakes or small sheets; the hard, dark grey, tessellated persistent bark (apparently secondarily absent in some species); the unthickened fruits; the non-folded cotyledons. The often irregular (metatopic) inflorescence branching may

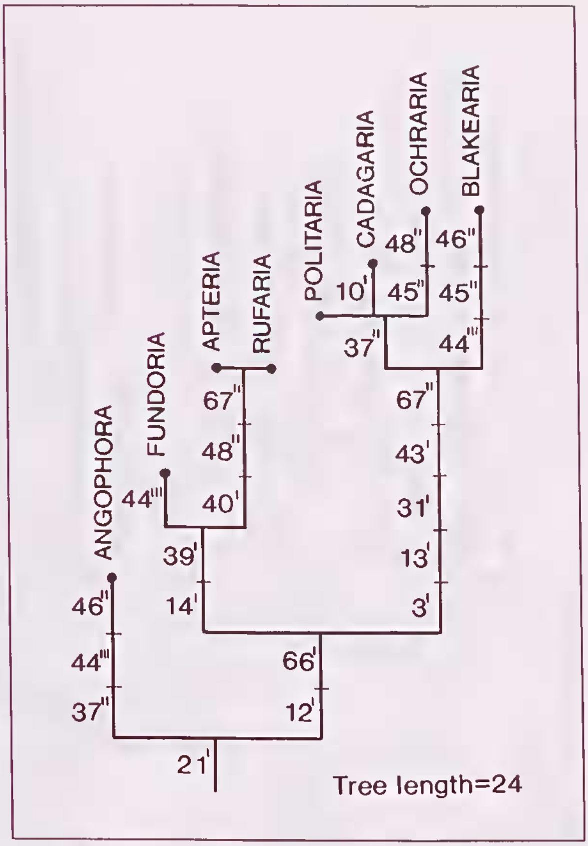

Fig. 4. One of four shortest phylograms (using unordered option, but containing no reversals), for characters as in Table 2. These differ only in the order of branching of *Ochraria*, *Cadagaria* and *Politaria*, which is unresolved in the corresponding consensus cladogram.

be added to these, as a tendency. The ghost gums share mainly plesiomorphic characters with the traditional 'bloodwoods', nevertheless they group consistently on synapomorphies with the yellow bloodwood-cadagi-spotted gum clade (sections *Ochraria* + *Cadagaria* + *Politaria*). The precise sister-group relationship among the latter remains uncertain. Direct or indirect links by hybridisation are known (see Appendix 1) between all *Corymbia* sections except for the unispecific *Fundoria* and *Apteria*. No such links are known with *Angophora*, despite frequent and much-observed co-occurrence of the genera.

1.8. Intrasectional relationships in *Rufaria* and *Blakearia*

Fourteen series are defined within the red bloodwoods of section *Rufaria*, some with subseries. We at first thought that their interrelationships were obscured by extensive homoplasy, though the series are well defined and the subseries group robustly in the analysis. However, careful reconsideration of the characters, with some redefinition and consequent re-scoring, has resulted in a fairly well resolved consensus tree (Fig. 5). For the series within *Blakearia*, see the formal treatment of that section.

The infrageneric classification adopted is summarised in Appendix 3.

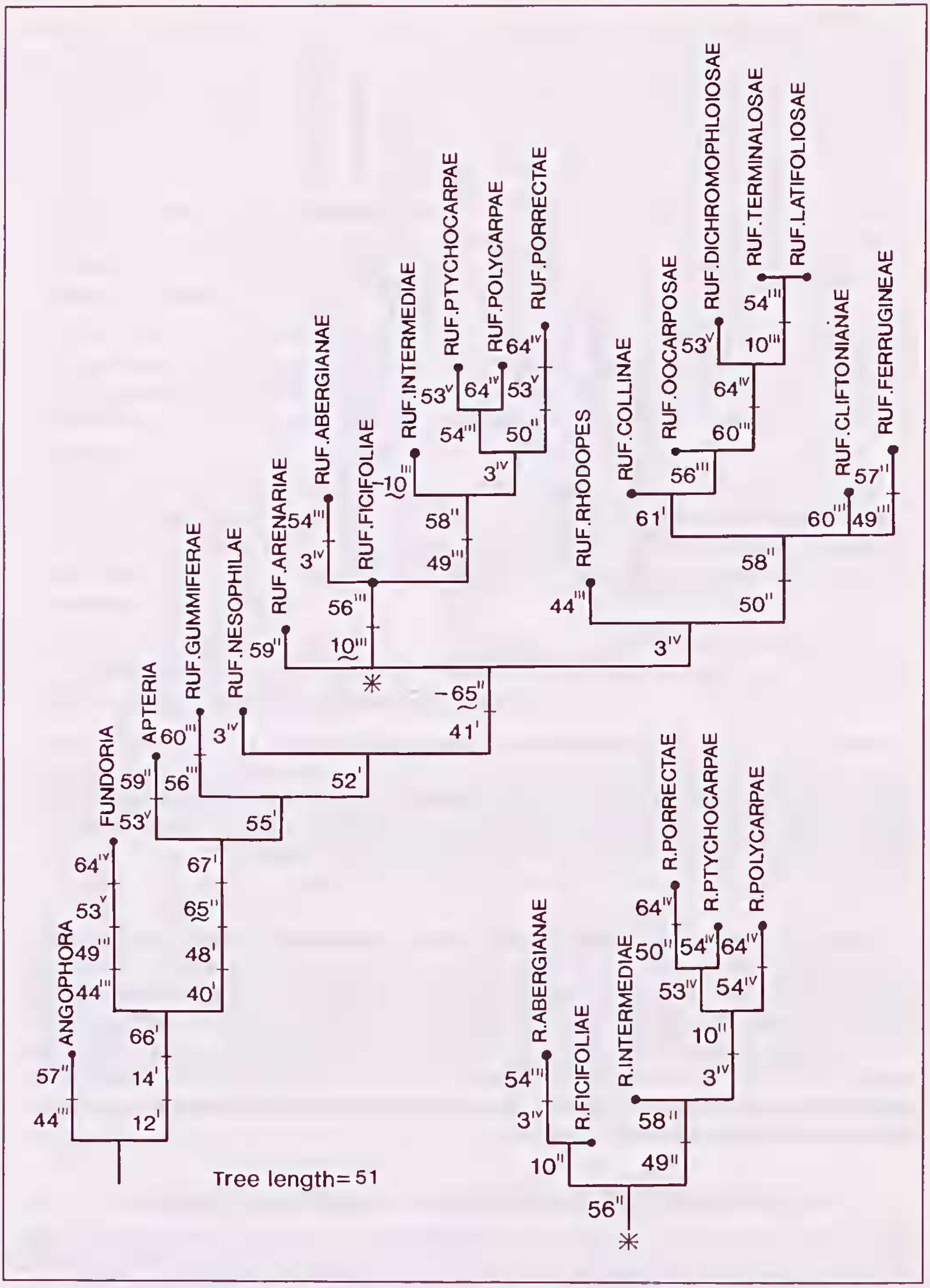

Fig. 5. Two shortest phylograms (identical except as shown from point *) for the augmented red bloodwood group, from 10 produced by PAUP constraining irreversibility except for characters 10 and 65, in which actual evolutionary reversion by suppression of ontogenetic stages is considered reasonable; from data of Table 3. Nine of the 10 trees differ only above point *; the tenth associates *Porrectae* with *Ferrugineae* because of common possession of apomorphies in characters 49 and 58, which we do not find convincing in view of their general dissimilarity. Primes as in Fig. 2; – (minus sign) indicates reversal, underlining by ~ indicates a character in which reversal occurs at some point.

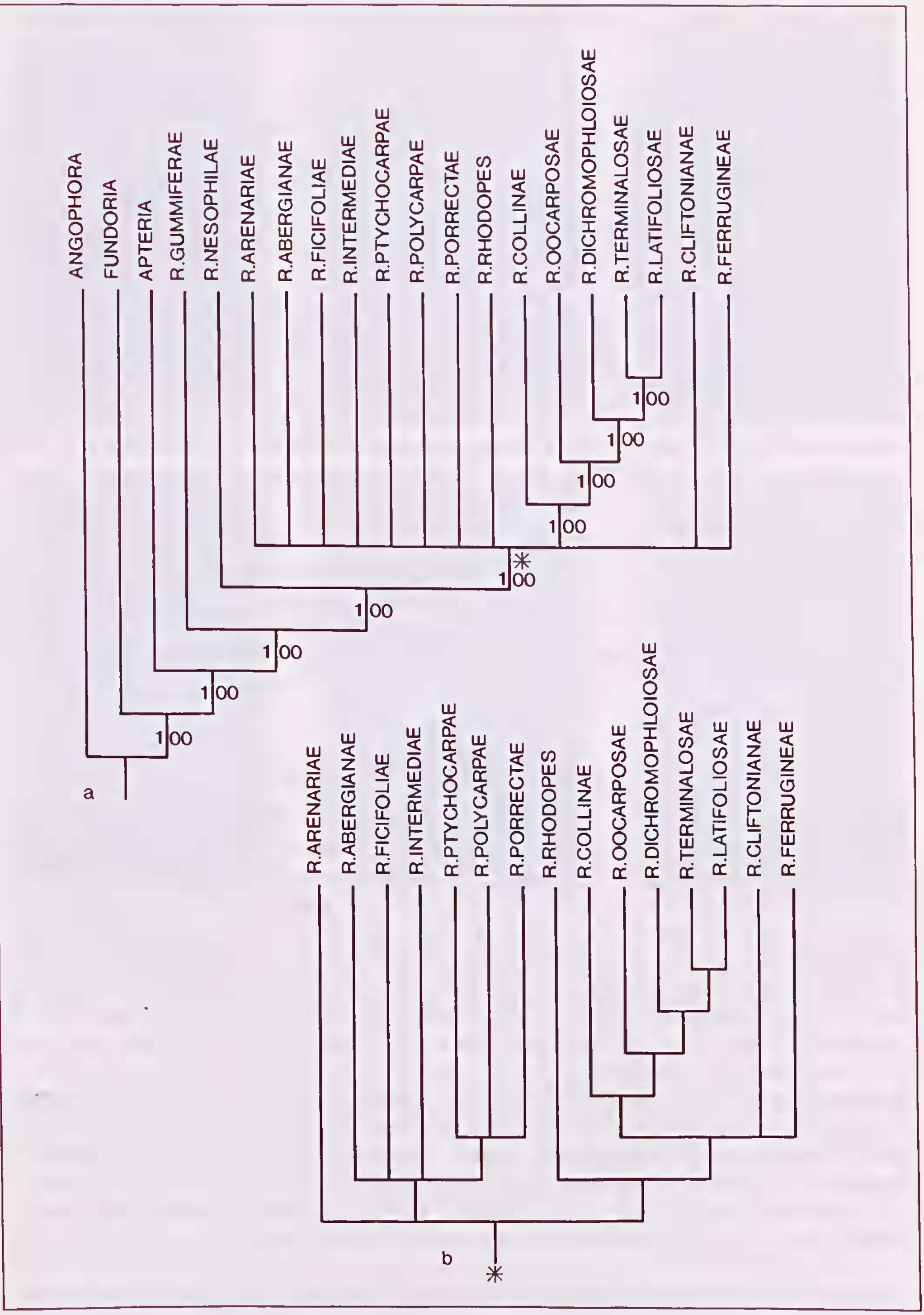

Fig. 6. a, Semistrict consensus cladogram derived from the 10 trees of which examples are shown in Figure 5. b, Alternative, more resolved consensus cladogram above point *, derived from first 9 trees mentioned under Figure 5. This appears reasonable. Note: The consensus cladogram produced by the unordered option is unresolved (except as to the association of *Rufaria* subseries *Terminalosae* and *Latifoliosae*) above the level of *Nesophilae*, but the individual trees concerned incorporate several reversals considered very improbable (see App. 2 (b) and text).

1.9. Characters in *Corymbia*

1.9.1. Bark

Evolutionarily, bark characters appear to be highly flexible, with both peeling and persistent types occurring in most groups of the *Angophora* clade (and indeed in most groups of eucalypts). In most members of the clade the bark has short fibres, and separates into more or less equidimensional polygons to give a tessellated appearance. Some taxa have somewhat longer fibres (e.g. several *Angophora* species, *C. ficifolia*, *Ochraria* species) and *C. jacobsiana* (section *Fundoria*) shows an unusual, long-fibred, somewhat 'stringy' but 'micaceous' bark. Certain groups with predominantly persistent bark types (*Apteria*, *Rufaria* and *Ochraria*) show apomorphically enlarged phloem fibres in the bark (Chattaway 1955), in both peeling and persistent types. These are not present in the also persistently rough-barked *C. jacobsiana* (section *Fundoria*) or in *Angophora*.

Species with partly peeling and partly persistent bark may show either a sharp demarcation between the two types, or a gradual transition with scattered adherent scales.

Sections *Apteria* and *Ochraria* have somewhat similar characteristically yellowish, soft and scaly persistent bark, while that of *Rufaria* is darker, usually pink to red-brown, and more compact. In section *Blakearia* the bark, when persistent, is even darker and more compact, rather similar to that sometimes occurring in section *Cadagaria*. In section *Politaria*, the spotted gums, the bark is wholly deciduous, but it tends to shed in ± isodiametric flakes, never in ribbons such as are frequent in non-bloodwood eucalypts.

1.9.2. Leaf venation and development

The augmented red bloodwood assemblage (*Apteria* + *Fundoria* + *Rufaria*), which appears to constitute a clade (Figs 4–6), possesses an advanced venation pattern in adult leaves, comprising closely-spaced parallel lateral veins at a wide angle to the midrib and a well-defined, straight and continuous intramarginal vein (Fig. 7). The intramarginal vein is an apomorphic development from the loops of a brochidodromous condition, and may be confluent with the leaf margin and not macroscopically discernible (at least on the adaxial surface), or separated from the margin by one or several rows of reticulations (see below, under other bloodwood groups). Lateral veins are separated by fine, regularly reticulate subordinate veins, usually defining two rows of 'islands' between each lateral vein. Intrusive mesophyll fibres (Carr et al. 1971) are associated with vascular strands (a plesiomorphy shared with *Angophora*), and a single oil gland is located in each 'island' defined by the reticulum. A fine branch vein may lead to the gland in some species. Other species have the oil glands partially or completely obscured by epidermal cells (although they are universally present, if not always numerous or even oil-bearing), but the regular reticulum and parallel lateral venation derived from secondary veins remains uniform in truly adult leaves. Series *Ferrugineae* is characterised by occurrence to varying degrees of a neotenous modified brochidodromous condition, retaining the widely-spaced looped primary lateral veins, between which there is a reticulum of closely-spaced more or less parallel lateral venation derived from the secondary veins (Fig. 7c, and see below).

The other traditional 'bloodwood' groups (*Ochraria* + *Politaria* + *Cadagaria*) and the ghost gums (*Blakearia*) possess a more plesiomorphic state in that lateral venation is more widely spaced and reticulation much more widely spaced. The lateral veins are still derived from secondary veins and arranged at a fairly wide angle to the midrib, and partial degeneration of the reticulation is an independent apomorphy,

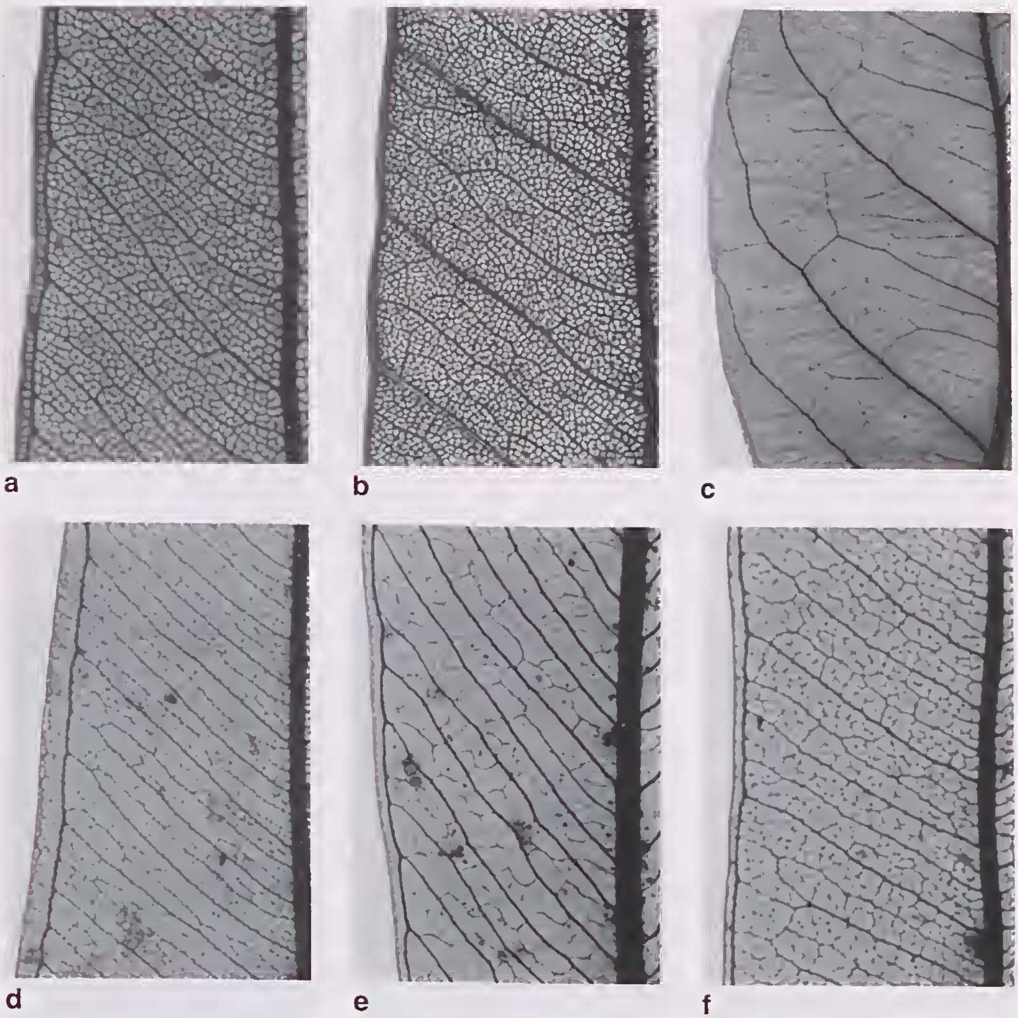

Fig. 7. Cleared adult leaves. a, *C. polycarpa* (from *Blaxell 89/097 et al.*). b, *C. terminalis* (from *Hill 3302*). c, *C. ferruginea* subsp. *ferruginea* (from *Wightman 2214*). d, *C. dimorpha* (from *Hill 3707 & Stanberg*). e, *C. citriodora* (from *Gittins 2503*). f *C. tessellaris* (from *NSW 240333*). Scale bar = 1 cm.

as is loss of intrusive mesophyll fibres. Brooker & Kleinig (1994, p. 47) point out that in '*Blakella*' there is 'multiple reticulation between intramarginal vein and leaf edge (compare with the usual single line or no line in bloodwoods)'. It is true that *Blakearia* retains this plesiomorphic condition, which is also seen in *Angophora* and in juvenile or neotenous leaves in *Corymbia* generally, but 'multiple reticulation' occurs also in fully adult leaves of some non-*Blakearia* species, for instance in *C. trachyphloia* (*Apteria*) and in *C. torelliana* (*Cadagaria*). Change from the plesiomorphic condition is not a synapomorphy for what Brooker and Kleinig distinguish from *Blakearia* as 'bloodwoods'.

Juvenile leaves commence at the first node after the cotyledons with a distinctly brochidodromous primary lateral venation and sparse intervening secondary reticulate venation (Fig. 8). This is clearly the basic condition in the family Myrtaceae and the order Myrtales (Johnson & Briggs 1984). Leaves of the various taxa (of all sections) are remarkably uniform at this stage, being ovate or lanceolate with bristle-glands and slender petioles, but generally lacking simple hairs. Early leaves appear 3-veined at the base because the first pair of primary lateral veins is developed more strongly than the remaining primary veins. Early leaves show sparsely reticulate secondary venation. The reticulation becomes finer in later leaves, with secondary veins eventually forming regular lateral veins at a high angle to the midrib. Every second such secondary vein becomes thicker and more prominent, and takes the place of the primary lateral veins. Secondary brochidodromous lateral veins become fewer and more widely spaced, eventually disappearing, except in *Rufaria* section *Ferrugineae* and in part of *Blakearia*, which in some species retain a neotenous condition with regular closely parallel high-angle secondary veins forming a reticulum between scattered looped primary veins. The reticulum concurrently becomes finer and more regular, and a clearly-defined continuous intramarginal vein is developed from the looped extensions of the primary lateral veins. One or more rows of tertiary reticulations usually develop between the intramarginal vein and the leaf margin. Most subseries of *Rufaria* series *Dichromophloiae* show a further modification, with the intramarginal vein so close to the thickened leaf margin as to appear confluent therewith even on the abaxial surface, and associated reduction of the marginal reticulations (Fig. 7b). It is never 'absent', though sometimes so indicated on collectors' labels.

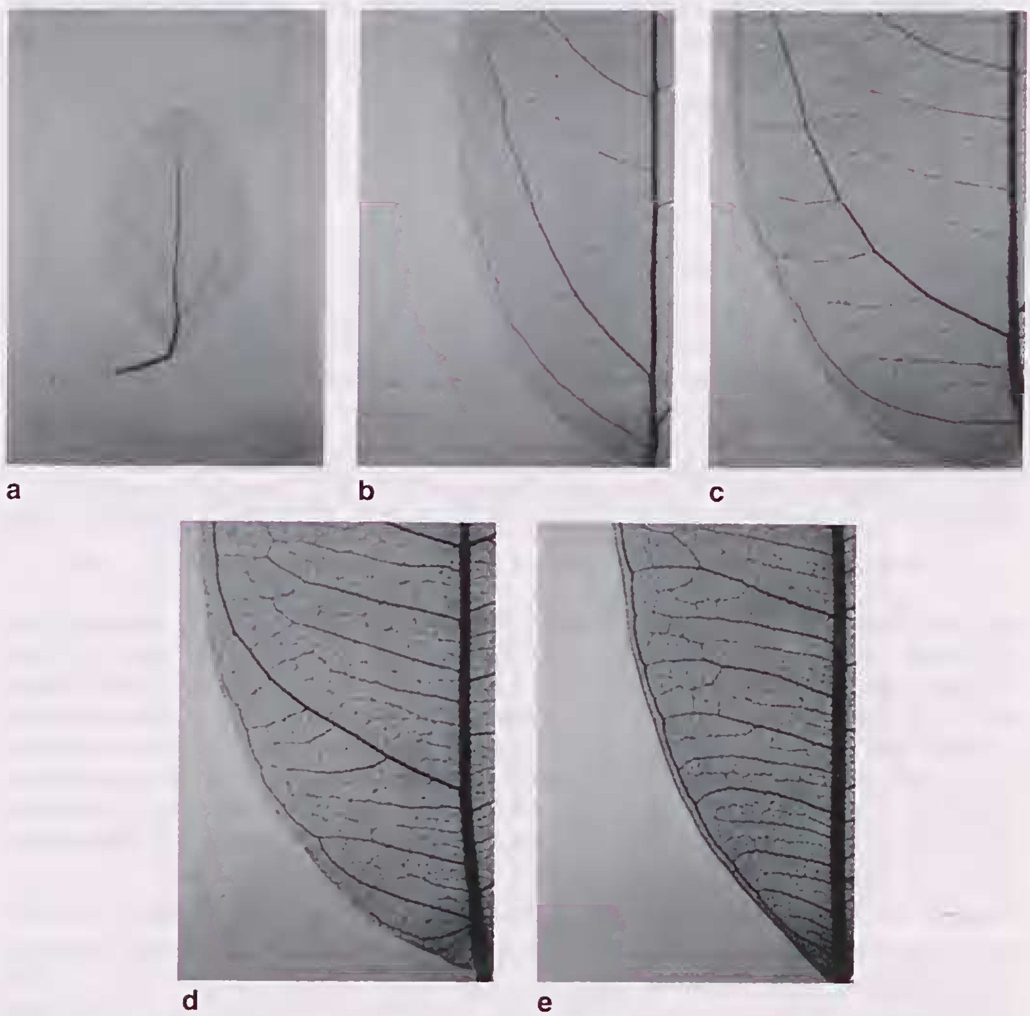

Fig. 8. Cleared juvenile leaves of *C. intermedia*. a, node 2. b, node 4. c, node 6. d, node 9. e, node 14 (cult. RBG, seed from *Hill 3794 & Stanberg*). Scale bar = 1 cm.

The earliest juvenile leaves are not cordate or peltate, but are commonly succeeded by cordate, 'subpeltate' or peltate, still 'juvenile', leaves between nodes 3 and 6. At least some of these are fully peltate in *Apteria*, part of *Rufaria*, part of *Ochraria*, *Cadagaria* and *Politaria*. The peltate stage usually persists for only a few of those nodes over which bristle-glands occur but may persist into the mature canopy in some members of *Ochraria*. Cordate leaves also sometimes occur in the crown in *C. ptychocarpa* (*Rufaria* series *Ptychocarpae*). The cordate and/or peltate phases are absent (apparently by secondary loss) in parts of *Rufaria* and *Ochraria*.

The petiole is slender in early stages, becoming distinctly thickened somewhere between the fourth and twelfth nodes in the progression from seedling to adult leaves. In both *Angophora* and *Blakearia*, juvenile leaves remain sessile for many nodes, and they are almost so in *Fundoria*. The petiole remains long in sections *Ochraria*, *Cadagaria*, *Politaria* and much of section *Rufaria*, notably in the plesiomorphic series *Gummiferae*.

Carr & Carr (1985, 1987) have segregated many new taxa in some series of *Rufaria*, largely on the basis of epidermal micromorphology of leaves and nectaries. In many cases, several supposed new taxa have been named within what is clearly one breeding population, for example *E. darwinensis* and *E. kakadu* in *C. foelscheana* in the country just south and south-east of Darwin, and the three supposed species *E. centralis*, *E. orientalis* and *E. opaca* (all referable to *C. opaca*) on the red-earth plains around Alice Springs. In other cases, specimens determined as a particular species supposedly on the basis of micromorphological detail belong to a number of distinct taxa; for example, specimens of *C. capricornia*, *C. oocarpa* and *C. drysdalensis* were cited as *E. ollaris* (now *C. umbonata*). This indicates that epidermal micromorphology varies somewhat within species and cannot be used alone in determining taxonomic limits. In particular, epidermal studies have not examined variation with ontogeny, or variation dependent on position within the canopy (as with 'sun' and 'shade' leaves in other taxa). Since the descriptions of new taxa and diagnostic details provided in the above publications are drawn from incorrectly determined specimens (e.g. specimens cited as *E. ollaris*, above), they must for the most part be disregarded, and application of the names must be based solely on the type specimens, with reference to taxa defined by the present study. We have studied populations at the type localities of all such unclear taxa.

The same authors introduce a number of confusing terms for stages of leaf development (Carr & Carr 1985). These terms merely represent arbitrarily chosen ontogenetic stages in the continuous progression from juvenile or seedling leaves to adult leaves. It is widely documented that mature eucalypts generally have the capacity to produce vegetative shoots from suppressed epicormic buds buried in the bark (Jacobs 1934, 1955; Boomsma 1972). Such shoots show varying degrees of ontogenetic reversion towards the juvenile stage, depending on the degree of suppression of the epicormic bud, which is itself partly dependent on the position of the bud on the plant, namely on lignotuber, trunk, branch or twig. Degree of reversion at different levels is also species-specific, i.e. genetically determined, although even the taxa most prone to substantial reversion do not show a complete return to earliest seedling-stage leaves. The ontogenetic stage to which reversion shoots return in a particular season is, however, flexible and environmentally determined. Terms used in this study will be *juvenile leaves* for the first 8–12 nodes after the cotyledons or for leaves that (with their associated internodes) retain bristle-glands, *adult leaves* for leaves occurring on mature reproductive shoots, and *intermediate leaves* for all morphologically distinguishable stages between. Flowering is by no means always ontogenetically fixed at a particular growth stage, and inflorescences may develop on shoots with various stages of intermediate leaves.

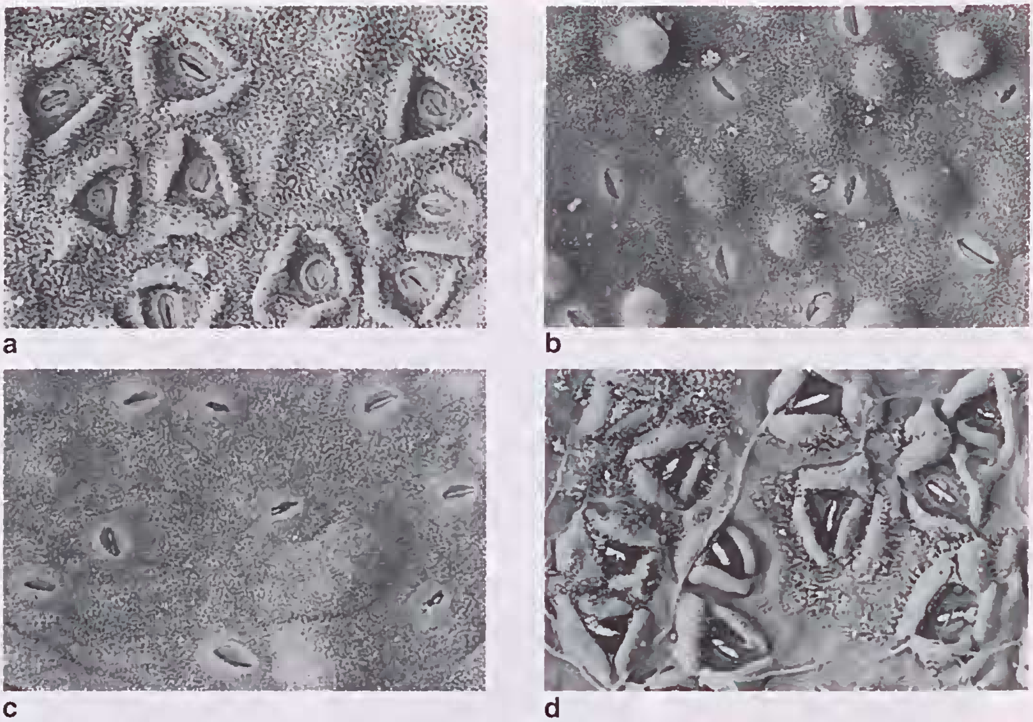

Fig. 9. SEM of leaf surfaces showing stomatal subsidiary cell morphology. a, *C. arnhemensis* subsp. *arnhemensis* (seedling from *Blaxell 88/136*). b, *C. arnhemensis* subsp. *monticola* (seedling from *Hill 3733*). c, *C. capricornia* (seedling from *Hill 3255*). d, *C. ferruginea* subsp. *stypophylla* (seedling from *Hill 3534*). Scale bar = 20 µm.

Certain features of epidermal micromorphology are, however, consistently different in different species. Heavily thickened subsidiary cells are a feature of section *Rufaria* series *Ferrugineae* (Fig. 9), occurring consistently in all taxa in the group. Most species of section *Rufaria* (except *C. nesophila*) possess stomatal crypts, whereas these are absent in all other sections.

1.9.3. Bristles and hairs

Corymbia and *Angophora* are characterised by two types of emergences: bristle-glands and trichomes (hairs):

1. **Bristle-glands** (Johnson 1972, Ladiges 1984) are more or less elongated multicellular structures with an axial oil gland (Fig. 10). They possess four cap cells with distinctive micropapillate ornamentation.
2. **Simple hairs** in *Corymbia* are single-celled, thin-walled, blunt-ended trichomes arising from undifferentiated epidermis (Fig. 10). In *Angophora* the simple hairs are uniseriately multicellular. In some series of *Corymbia* section *Blakearia* each epidermal cell on the abaxial surface bulges to produce a short papilla: these appear to be a development separate from the scattered trichomes. We describe such surfaces as finely papillate.

Both emergence types (but not the short bulging papillae) are developed primarily on juvenile foliage, although they may also occur on later stages in neotenous species. The degree of development and persistence is highly variable overall, but is species-specific. In particular, some species and species-groups may show suppression of the simple hairs. Species in which they occur usually do not show development of simple hairs until about the fifth node in seedlings, although a few simple hairs may be present on cotyledons, and are sometimes found on the hypocotyl and cotyledon petioles in species of sections *Ochraria* and *Politaria*, from which they are otherwise absent.

C. *ferruginea* and some related taxa of section *Rufaria* series *Ferrugineae* show an autapomorphic development of 'stellate' structures (Fig. 10), resulting from development of simple hairs on the raised portion of the oil glands (but not on the four cap cells) in addition to simple hairs arising from undifferentiated epidermis. Such structures, as originally stressed by Johnson (1972), are *not* 'stellate hairs', as they have often been loosely termed. A somewhat similar, apparently parallel, development also occurs in several members of *Blakearia* (e.g. C. *gilbertensis*, C. *dendromerinx*). In the non-bloodwood eucalypts ('the *Eucalyptus* clade'), thin-walled, blunt hairs occur on slightly (but not setiform) raised oil-glands in most species of subgenus *Eudesmia* s. lat., as well as a few in subgenus *Symphyomyrtus*. In the stringybark group (part of subgenus *'Monocalyptus'*) unicellular hairs occur in this position, but in this case they are thick-walled and acute (Johnson 1972, Ladiges 1984).

1.9.4. Inflorescence structure

Unit inflorescences (Johnson 1976, *uniflorescences* of Briggs & Johnson 1979) in the bloodwoods are regular 7-flowered umbellasters (3-flowered in some species), aggregated into compound branched anthotelic or anauxotelic structures in terminal

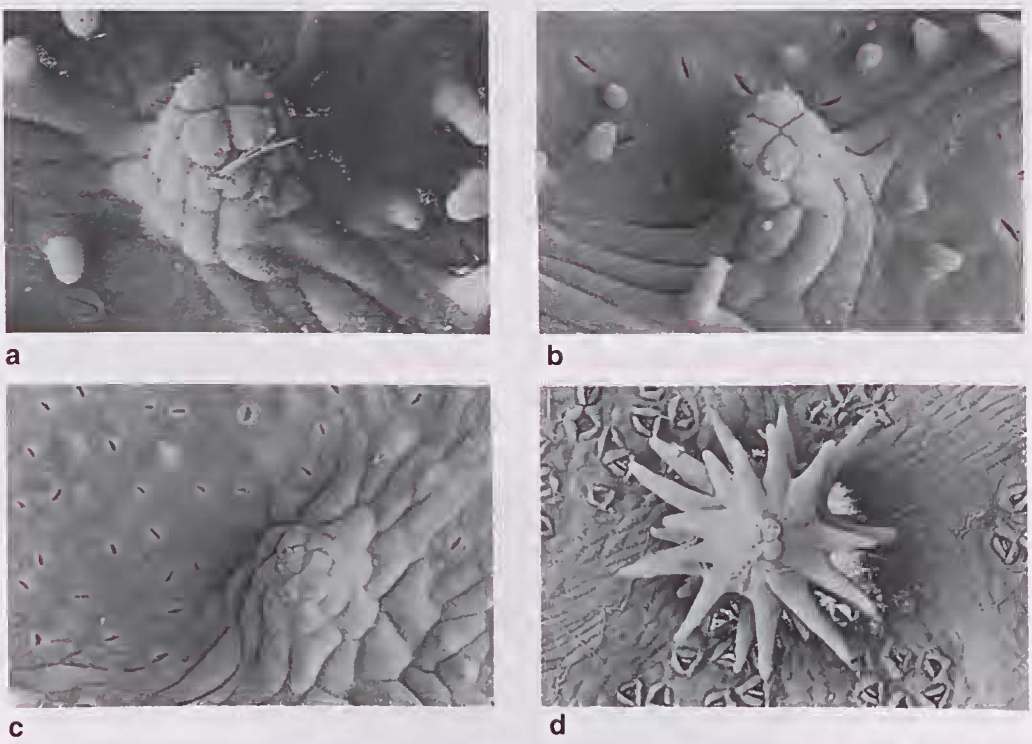

Fig. 10. SEM of leaf surface of juvenile leaves. a, C. *collina*, (seedling from *Hill 3391*). b, C. *arnhemensis* subsp. *arnhemensis* (seedling from *Blaxell 88/136*). c, C. *capricornia* (seedling from *Hill 3255*). d, C. *ferruginea* (seedling from *Hill 3534*). Note: 1, bristle glands. 2, simple hairs. 3, four micropapillate cap cells. 4, stellate structures resulting from development of simple hairs on bristle glands in d. Scale bar: a, b = 50 µm, c, d = 100 µm.

or lateral situations. All branches are subtended by paired opposite deciduous prophylls ('bracts'). The whole inflorescence appears to be derived from a flexible (anthotelic/anauxotelic) condition characteristic of ancestral Myrtaceae, in which the branching structure (of anthotelic portions or the whole) is that of a panicle or thyrsoid. This is discussed by Briggs & Johnson (1979), who stress that they use *panicle* in the essentially Trollian sense of a branched plurinodate anthotelic inflorescence, not in the vague ways that it has been employed by most writers in the English language. In *Corymbia*, as in *Angophora*, the *umbellasters* (Johnson 1976) are final, usually 7- or (by further reduction) 3-flowered, condensed portions in which penultimate internodes are not elongated. These umbellasters can correspond with condensed dichasia; there is no indication that the condition is derived from metabotryoids as it evidently is in *Eudesmia* s. lat. and probably other non-bloodwood eucalypts. *Blakearia* inflorescences often appear considerably modified, sometimes by metatopy (Briggs & Johnson 1979), although they have the same basic structure; they are discussed in more detail under *Blakearia* in the taxonomic treatment (see section 2, Taxonomy).

Although frequently terminal on leafy shoots, inflorescences do not display a regular pattern of terminating such seasonal growth units (SGUs). Flowering is more often opportunistic in response to seasonal conditions, with inflorescences sometimes developing on shoots with intermediate foliage characters. Some species, however, are more seasonally regular than others in flowering. In many species of *Blakearia* (q.v.) of monsoon woodlands, actual flowering occurs when the trees are largely leafless during the dry season. Recorded flowering times (from herbarium specimens) are listed under each taxon.

1.9.5. Floral structure

Bloodwood flowers show little diversity in structure. All have fused sepals, forming a patelliform to shortly conical calyptra. In the red bloodwoods in the broad sense (*Fundoria*, *Apteria* and *Rufaria*) this persists to anthesis; in the other sections it falls before that stage. In *Fundoria* and *Apteria* the petals are not fused, though they are closely appressed to the calycine calyptra and fall with it. In *Rufaria* there is a range from some taxa showing distinctly wholly free petals (e.g. *C. ficifolia*) to others that display a more or less 'fused' corolline calyptra that is usually very thin and adheres closely to the sepaline calyptra, forming an effectively single calyptra that is shed as such at anthesis (see Willis 1951). Though later broad-based, petals originate with a 'claw-and-limb' structure (Drinnan & Ladiges 1988), and remain free at least at their apices. Developing buds in some cases show a scurfy epidermis developed through breakdown of the rubbery cuticle (discussed by Carr & Carr 1987, 1988). The rubbery cuticle is usually preserved on the inner calycine and corolline calyptras. *Blakearia*, *Ochraria*, *Cadagaria* and *Ochraria* develop a more substantial corolline calyptra (substantially thickened in *Ochraria*) with a heavy rubbery cuticle. This calyptra sheds after (in the case of *Politaria*, only shortly after) the calycine calyptra.

The androecium is developed on the receptacle ('floral apex'), in contrast to the epipetalous stemonophore of *Eucalyptus* sensu semistricto (see Drinnan & Ladiges 1989a). The stamens are all fertile and regularly inflexed throughout (Fig. 11), with oblong or oblong-obovate, dorsifixed, versatile anthers dehiscing by parallel longitudinal slits (Fig. 12). This is clearly a plesiomorphic state within the eucalypts, and indeed within the Myrtaceae (Johnson & Briggs 1984). Oil glands may or may not be present in filaments, anther connectives, anther lobes or style. These characters appear inconstant within some species, but some may consistently lack them. Further reliable observations are required.

The style is also uniform in structure in the red bloodwoods, with a shaggy stigma of unicellular or bicellular, elongate papillae with a thick cuticle (Fig. 13, see also

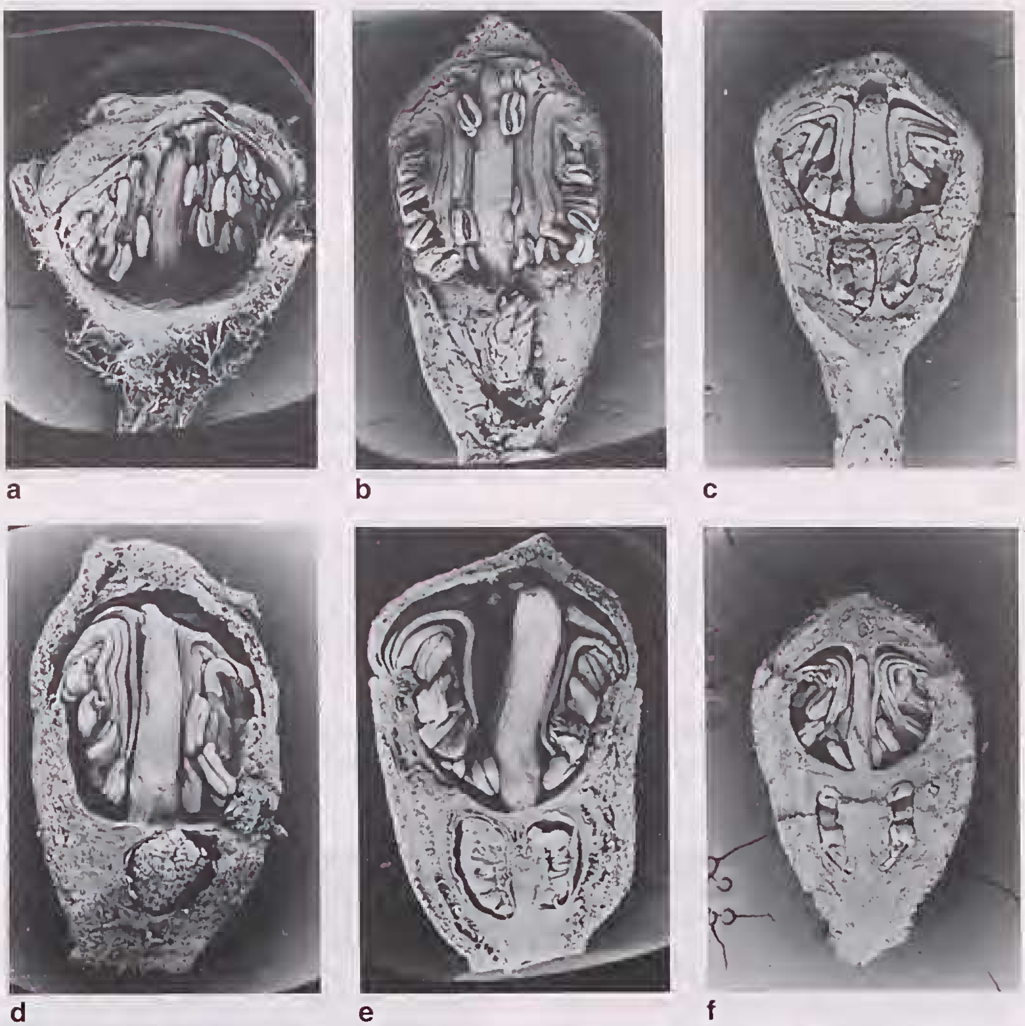

Fig. 11. Longitudinal sections of buds. a, *Angophora hispida* (from *NSW 355428*). b, *Corymbia intermedia* (from cult., *RBG 790022*). c, *C. leichhardtii* (from *Blaxell 1632*). d, *C. torelliana* (from cult., *RBG 8447*). e, *C. maculata* (from cult., *RBG 15817*). f, *C. paractia* (from *Willing 112/113*)). Note: 1, regularly inflexed filaments. 2, irregular arrangement of ovules on placenta. 3, Style tip engaged in calyptra in c and e. Scale bar = 2 mm.

Fig. 12. Anther of *C. citriodora* (from cult., *RBG 14115*). Scale bar = 500 µm.

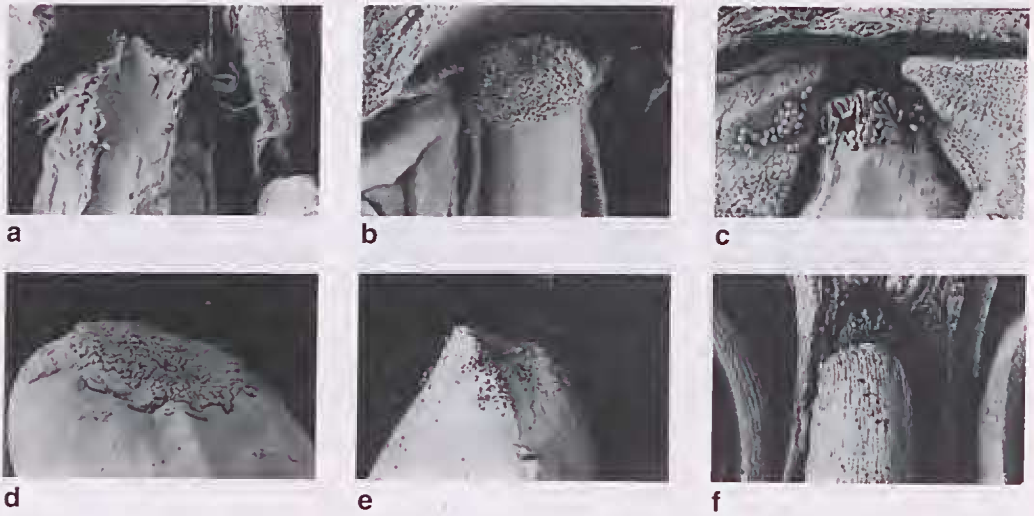

Fig. 13. Stigmatic structure. a, *Angophora hispida* (from *NSW 355428*). b, *Corymbia ptychocarpa* subsp. *ptychocarpa* (from *Blaxell s.n., RBG spirit 1786*). c, *C. intermedia* (from cult., *RBG 790022*). d, *C. maculata* (from cult., *RBG 15817*). e, *C. watsoniana* subsp. *watsoniana* (from cult., *RBG 16233*). f, *C. paractia* (from *Willing 112/113*). Note: long papillae (a, b, c); short papillae (d, e, f). Scale bar = 200 µm.

Boland & Sedgley 1986). This differs from the also uniform stigma structure of the yellow bloodwoods, the spotted gums and the ghost gums, which possess a smooth stigma of short, closely packed unicellular papillae. The elongate papillae represent the primitive condition, which is shared with *Angophora* and the *Arillastrum* alliance. The papillae are further reduced in the ghost gums. The yellow bloodwoods display a distinctively thickened inner calyptra with the style tip deeply engaged in a pit within it. Section *Cadagaria* lacks this, but has the style bent near the tip in bud, which section *Politaria* may also show in an incipient condition. Section *Blakearia* does not have the thickened inner calyptra, but has the style engaged in a pit formed from an inward projection of the inner calyptra. The pit and bent-style conditions are apomorphic, as is the shortly papillate stigma (Figs. 11, 13).

The most common gynoecial condition is 3-carpellate, but occasional 4-carpellate flowers (and hence 4-locular capsules) may be found in most species, and reduction to two carpels occurs in occasional individual flowers. In much of section *Rufaria* 4-carpellate flowers occur in what is possibly an apomorphic fixation of that condition; a flexible 3-4-carpellate condition is found in apparently plesiomorphic members of that section (e.g. *C. gummifera*). It is possible that the >3-carpellate condition is a reversion within the *Angophora* + *Corymbia* clade; on the other hand, less reduced gynoecia appear to be plesiomorphic in the family as a whole (Johnson & Briggs 1984). Species of section *Rufaria* that are usually 4-carpellate sometimes have occasional 5- and 6-carpellate flowers; this is most common in species with relatively large buds and fruits (e.g. *C. ptychocarpa*). Placentation is axile, with the placenta peltately attached to a column that persists in fruit as a columella (caducous in *C. torelliana*, constituting section *Cadagaria*).

Many red bloodwoods, in particular those of series *Polycarpae* and also *C. calophylla*, have the capacity to set sterile fruits from functionally male flowers (see Carr et al. 1971). This can yield apparently mature fruits lacking fertile seeds; such fruits are considerably smaller than fertile fruits from the same species. Fruit-size measurements given in descriptions cannot always account for such occurrences, and lower limits in specimens bearing sterile fruits may be lower than those recorded.

1.9.6. Pollen

Pollen morphology has not been extensively studied in the group. Chalson & Martin (1995) give references to previous, not very helpful, studies. They also show that, from a limited sample, pollen morphology in species referred by us to *Corymbia* is similar to that in *Angophora* and less so to that in the non-bloodwood eucalypts.

1.9.7. Ovules

The *Angophora* + *Corymbia* clade shows a consistent difference in ovule arrangement from the *Eucalyptus* (non-bloodwood) assemblage. In the latter the ovules are arranged on the placenta in two or four regular vertical rows (depending on species, with occasionally more rows in some species — see Boland et al. 1980). *Angophora* and *Corymbia* do not display regular rows, but have ovules randomly closely packed on the placenta. Vertical rows may sometimes be discerned within the aggregation, but, when present, these do not run uniformly vertically (Fig. 14).

1.9.8. Seeds

The genus *Corymbia* shows a number of striking differences in seed structure (see also Boland et al. 1980). The plesiomorphic condition appears to be a dorsiventrally flattened patelliform structure, with a glossy, red-brown verrucose surface formed from rounded, lightly sculptured epidermal cells of the outer integument (Figs. 15, 16). This condition occurs in *Angophora* and in *Corymbia* sections *Fundoria*, *Apteria*, *Politaria*, *Ochraria*, *Cadagaria* and *Blakearia* (i.e. all sections except *Rufaria*). Sections *Politaria*, *Cadagaria* and *Ochraria* share with *Angophora* the fine, regular cracking of

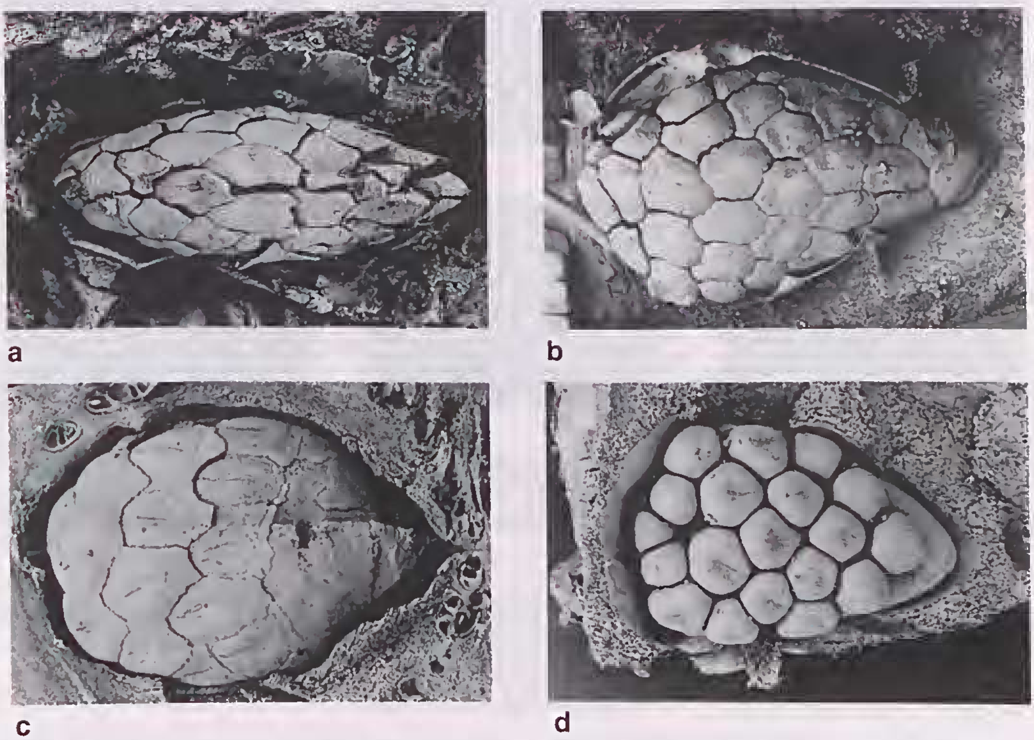

Fig. 14. Ovule arrangement. a, *C. intermedia* (from cult., *RBG 790022*). b, *C. maculata* (from cult., *RBG 15817*). c, *C. leichhardtii* (from *Blaxell 1632*). d, *C. paractia* (from *Willing 112/113*)). Scale bar: a, c = 1.00 mm; b, d = 500 µm.

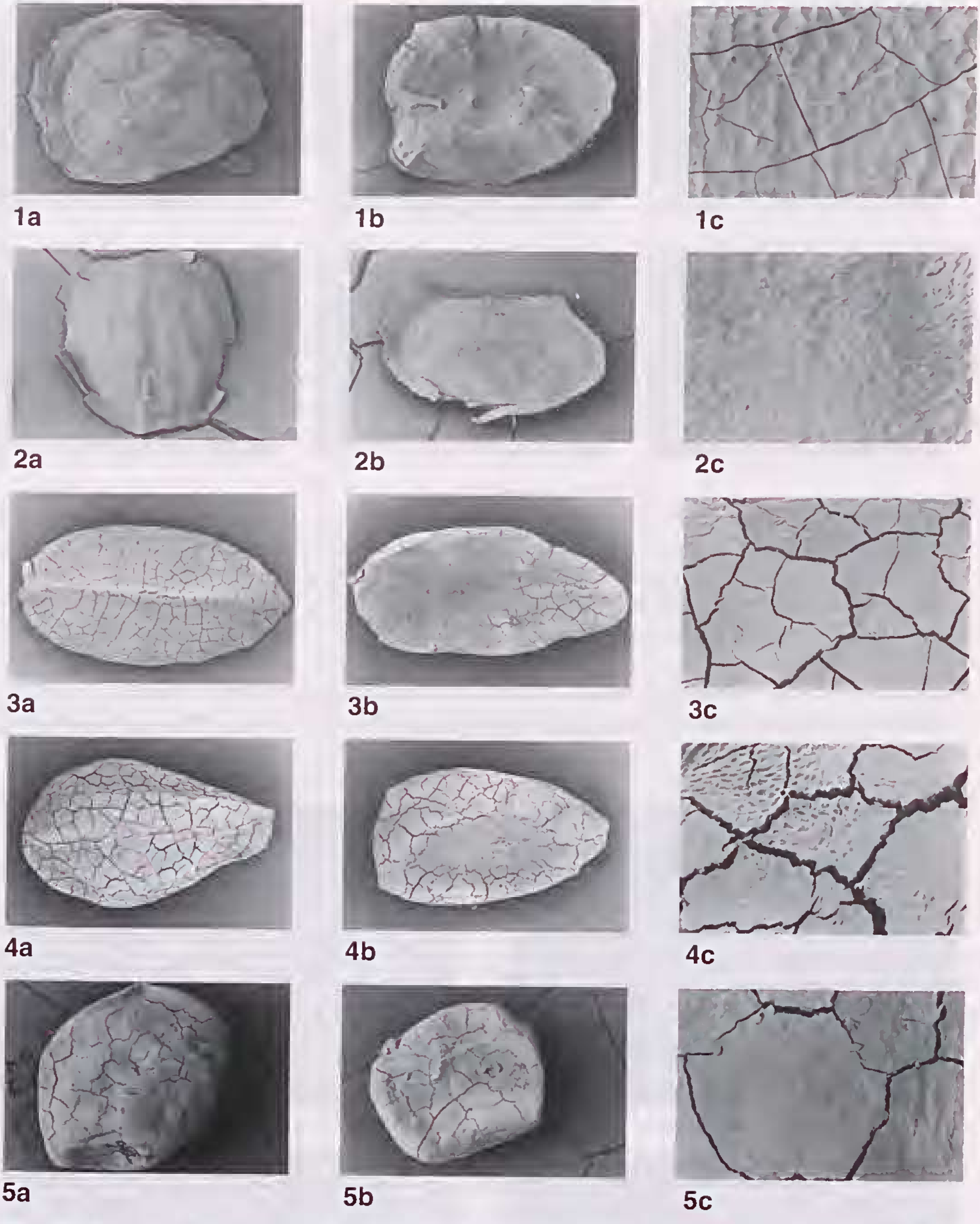

Fig. 15. Seeds. 1, *Angophora melanoxylon* (from *Coveny 12609*). 2, *Corymbia tessellaris* (from FRI seedbank). 3, *C. leichhardtii* (from *Hind 2485*). 4, *C. variegata* (from *Blaxell 89/291*). 5, *C. torelliana* (from cult., *RBG 8447*). a, dorsal view, b, ventral view (scale bar: 1, 2 = 2 mm; 3, 4, 5 = 1 mm), c, seed coat (scale bar = 200 µm).

the testa in mature seeds (Fig. 15), which may be a synapomorphy for these groups but, if so, has been lost in *Blakearia* and presumably in the remaining sections; alternatively the condition may have arisen separately in *Angophora* and the *Ochraria* + *Cadagaria* + *Politaria* group, despite its distinctive nature.

Section *Rufaria* also shows substantial intrasectional seed differences. All species have laterally flattened seeds with a generally smoother seed coat. Series *Gummiferae* has cymbiform seeds, one species within the group (*C. calophylla*) having a strikingly

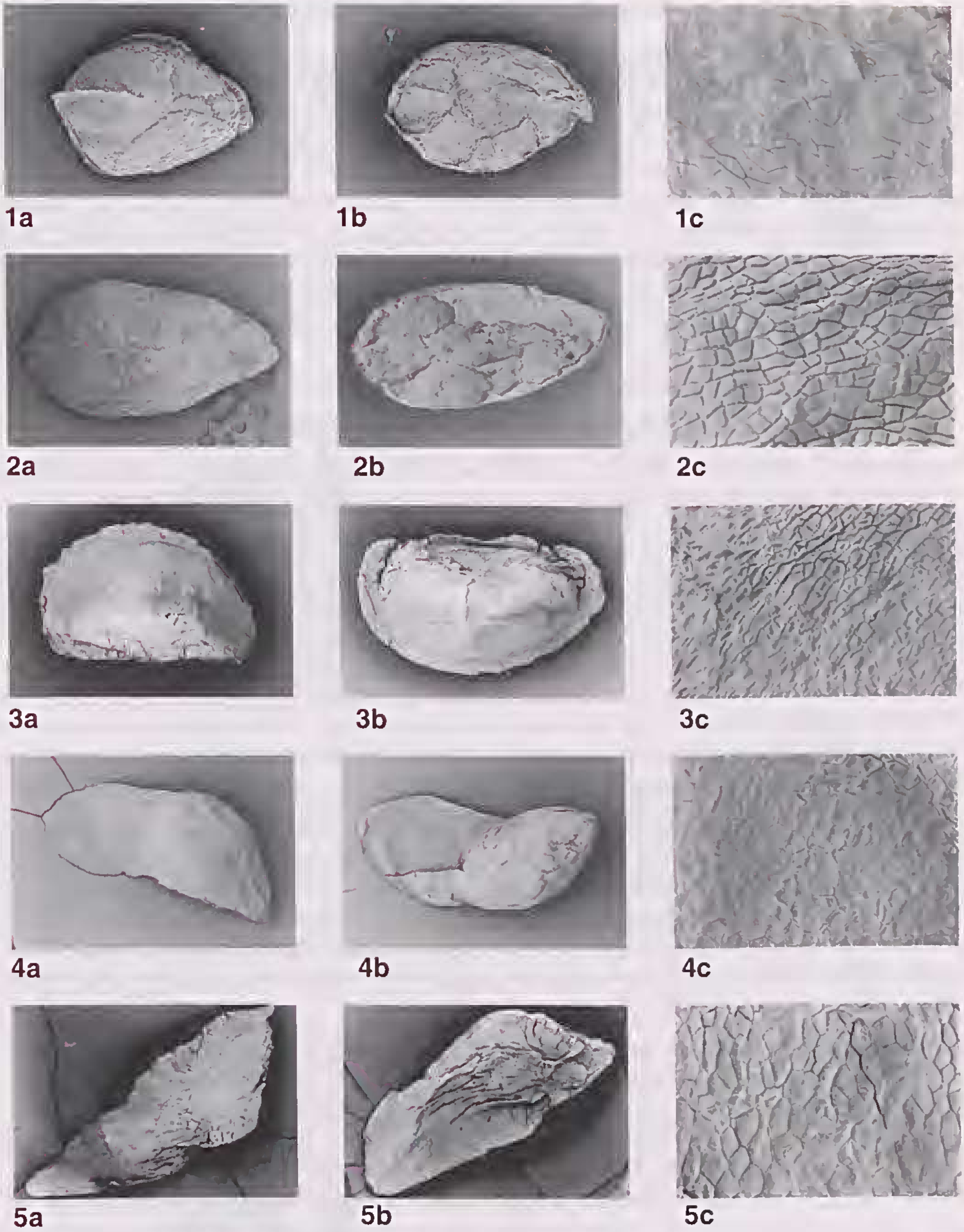

Fig. 16. Seeds. 1, *Corymbia trachyphloia* subsp. *trachyphloia* (from *Hill 3598*). 2, *C. jacobsiana* (from *Hill 913*). 3, *C. gummifera* (from *Hind 5629*). 4, *C. capricornia* (from *Hill 3258*). 5, *C. terminalis* (from *Hill 3590*). a, dorsal view, b, ventral view (scale bar = 1 mm (1, 2), 2 mm (3, 4, 5), c, seed coat (scale bar = 200 µm).

autapomorphic black seed-coat. All other *Rufaria* species display remarkably uniform seeds, red-brown or mid-brown in colour, with a non-vascularised, hyaline terminal extension (referred to herein as a wing, following general usage) developed from the outer integument (Fig. 15, 16, and see Gauba & Pryor 1961).

'Chaff' (sterile 'seeds', mostly developed from ovulodes) also varies in shape, from roughly equidimensionsal or blocky in the groups with dorsiventrally flattened seeds, to elongated and more or less linear in the groups with laterally compressed seeds.

1.9.9. Rhizomes and lignotubers

Rhizomes are recorded (Lacey 1974), or have been observed by us, in several species from different groups within *Corymbia*. Further careful observation is required to establish the full extent of this feature but, at this stage, it appears that possession of rhizomes is either a synapomorphy in sections *Fundoria*, *Apteria* and *Rufaria* (the red bloodwoods in the broad sense) and later lost in many species, or has arisen independently several times within the red bloodwoods. Taxa known to possess rhizomes are *C. jacobsiana*, *C. trachyphloia*, *C. ptychocarpa*, *C. porrecta*, *C. hylandii* (both subspecies) and *C. erythrophloia*. Broad plate-like underground structures interpreted as lignotubers are known (Bamber & Mullette 1978; Mullette 1978) in some populations of stunted *C. gummifera*, and apparently occur also in *C. chlorolampra*, *C. haematoxylon* and *C. calophylla* (all in series *Gummiferae*).

1.10. Biogeography and ecology

A number of relictual distribution patterns can be perceived in *Corymbia*, overlaid by several apparently recent patterns of radiation and vicariant speciation.

In *Rufaria*, the distribution of *C. gummifera* in eastern Australia, as against its probable sister complex of *C. calophylla*, *C. haematoxylon* and *C. chlorolampra* in the south-west, is relictual, though wide (Figs 21–23, 25). The south-western monotypic series *Ficifoliae* is also disjunct from possible relatives in eastern Australia, though precisely what its sister-group may be is not certain; a particular relationship with the monotypic *Intermediae* has been suggested but there are considerable differences, likewise with the more northern but still wet-climate *Abergianae* (Figs 27–29). Such disjunctions imply a substantial evolutionary separation within the bloodwoods before the middle-Miocene isolation of the south-east and south-west of Australia.

A possibly more recent relictual pattern occurs across the tropics in the subseries *Arenariae*, with two vicariant species (one with two disjunct subspecies) in widely separated refugial sites in Western Australia, the Northern Territory and Queensland (Fig. 45). This might be suggested as paralleled by the disjunction of sections *Fundoria* and *Apteria* (Fig. 17), but the latter pair are more evolutionarily divergent and do not appear to constitute a clade in themselves, hence they must reflect an older disjunction (Figs 4–6).

Still more recent dispersal and vicarious speciation patterns are indicated by three partly sympatric groups within *Rufaria* across the tropics, the *Polycarpae* (Figs 32, 33, 37), the *Latifoliosae* (Figs 61, 62) and the *Dichromophloiosae* (Figs 50, 52). The subseries *Terminalosae* shows similar speciation patterns across the semi-arid and arid regions of Australia (Figs 54, 55, 56, 58), and the *Ferrugineae* (Figs 65, 68, 71, 74, 79) show a similar pattern across a wider area from the wet monsoon tropics into the tropical arid zone. These patterns are all consistent with a major radiation and migration in the tropical bloodwood flora in relatively recent times, with even more recent isolation and speciation events, and doubtless some shifts of population areas, leading to the mosaic pattern now seen. In *C. latifolia* the gap between the Northern Territory (to the west) and Torres Strait to southern Papua New Guinea (to the east) (Fig. 61) may or may not represent a more recent dispersal pattern. It is noteworthy that, at all levels, groups showing some plesiomorphic character-states occur in regions of relatively humid climate, while those in regions subject to more pronounced or long-term drought tend to show more apomorphy.

Similar east-west patterns occur in *Blakearia* (see discussion under that section in the taxonomic treatment). North-south replacement patterns, with various degrees of disjunction, are evident in some series of *Rufaria* (e.g. *Polycarpae*, *Rhodopes*), as well

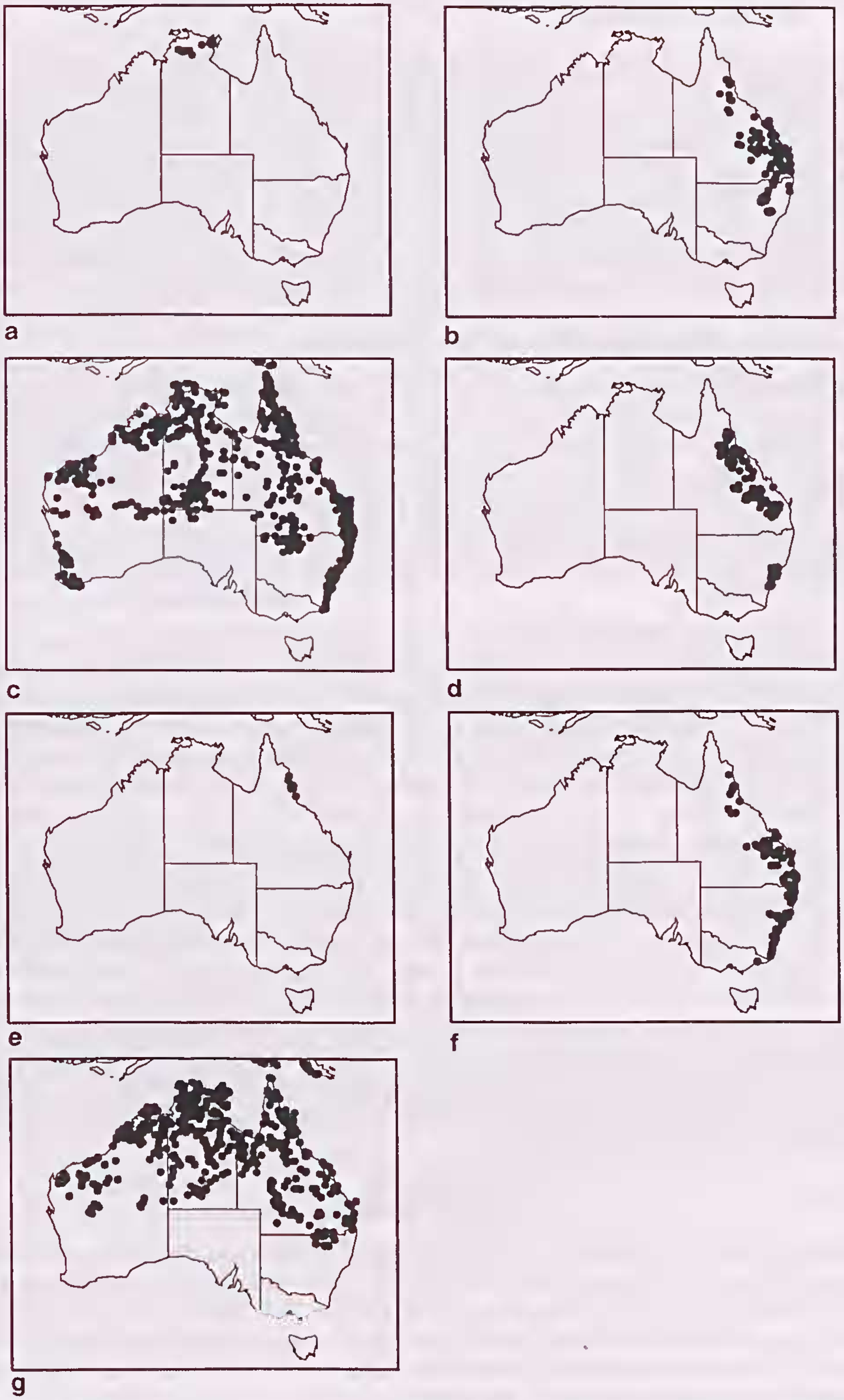

Fig. 17. Distribution of sections *Fundoria* (a), *Apteria* (b), *Rufaria* (c), *Ochraria* (d), *Cadagaria* (e), *Politaria* (f), *Blakearia* (g).

as in *Ochraria* and *Politaria*; these are all somewhat complicated by some replacement, corresponding with habitat difference, within regions of similar latitude (see maps under the taxa concerned).

Another pattern (in some groups only) shows in the occurrence of species in low-rainfall regions that are related to species in moister, especially monsoonal, zones. In these semi-arid and arid habitats almost all species (which are generally more apomorphic in habitat-related respects) have clearly close, and presumably older, relatives to the north or east. Examples of moist–arid pairs are *C. papillosa* and *C. deserticola* (*Rufaria* series *Ferrugineae*), *C. aspera* (relatively moist) and *C. punkapitiensis* (extremely arid) (*Blakearia* series *Aridae*), and also *C. dallachiana* and *C. aparrerinja* (*Blakearia* series *Grandifoliae*), but there are many others. In one puzzling case, *C. chippendalei*, there is no apparent sister species in higher-rainfall country, although other species in *Rufaria* series *Dichromophloiae* subseries *Terminalosae* have a general relationship with this inhabitant of desert sandhills.

Most commonly, members of sister pairs (in any climatic zone) occur on similar substrates, but in other cases such members are found on substrates that differ physically or chemically, for instance, in *Terminalosae*, *C. lenziana* on level sands and the very similar *C. eremaea* on rocky sites or occasionally on the higher parts of sandhills; in another subseries (*Dichromophloiosae*) of *Dichromophloiae*, *C. ellipsoidea* and *C. porphyritica* occur respectively on moderately and very nutrient-deficient substrates in contrast to the related *C. erythrophloia*, which grows on substrates of moderate fertility.

The marked and consistent difference between the rocky habitat of *C. aspera* and the level sandy habitat of *C. candida* has been obscured by persistent non-recognition of the clear morphological and habit differences between these species (e.g. in Brooker & Kleinig 1994). In the same group as these (*Blakearia* series *Asperae*), the limits and coherence of *C. ferriticola* are clarified when one recognises its consistent occurrence on rocky sites, even when these are worn-down remnants in the desert, as they are with subsp. *sitiens*.

Those series, subseries or species with most apomorphic states, especially in *Rufaria*, are often in habitats with less nutrient-deficient soils. Examples are series *Intermediae*, *Ptychocarpae*, *Polycarpae* and also the three *Dichromophloiae* subseries *Dichromophloiosae* (in part), *Terminalosae* and *Latifoliosae*, though some other advanced groups also have members on deficient substrates. It may be suggested that the less oligotrophic substrates became available to bloodwoods (and other eucalypts) only after reduction of closed forests by climatic and associated changes. Doubtless changes in fire and grazing regimes since the arrival of *Homo sapiens* have been responsible for some contractions and expansions of range, but there is little to suggest that the general replacement patterns and the relations to substrate have been altered by these processes, as distinct from climatic change.

1.11. Hybridism

Hybridism has been recognised as a frequent and widespread occurrence within the eucalypts (Pryor & Johnson 1971, 1981; Pryor 1976), although some authors have greatly underestimated its frequency of occurrence. Both inter- and intra-sectional hybrids occur in the bloodwood groups, and are discussed below under each species involved. To simplify citation, selected specimens of the hybrids or intergrades recognised are cited separately in Appendix 1.

Several classes of hybrid may be recognised, but these are reduced to two categories in the listings. The first includes simple F_1 hybrids that occur spontaneously where conditions permit, and are morphologically intermediate between the two parent taxa. These are identified in discussion and citation below by placing the symbol 'x' between the names of the parents, which are listed in alphabetical order both down and across the list in Appendix 1.

The second, rather broader, category distinguished is that of the hybrid assemblages removed several or many times from the F_1 generation. These usually occur as populations, and may or may not display Mendelian segregation within the population (possibly depending on the number of generations removed from the F_1 stage, and the consequent degree of (selective?) homogenisation or of clinality). Such populations are again morphologically intermediate between the parent taxa, and are referred to in the text as intergrades. They are distinguished in the listing below (Appendix 1) with a ' – ' symbol between the names of the parents. We have applied formal botanical names to intermediate but fairly homogeneous populations in the few cases where these are clearly established as independent of the parent species and self-sustaining, and these are treated as species within the main body of the text, especially where their parentage involves members of different series or subseries. Such cases are *C. opacula*, *C. pedimontana*, *C. paractia* and possibly also *C. clavigera*, as well as the intraserial *C. semiclara*, *C. dimorpha* and *C. catenaria*. The question has been asked, 'How can the authors possibly *know* this?'. The rather obvious rejoinder is that we do not 'know' but that the origin of such populations by genetic interchange ('interbreeding') provides a more reasonable hypothesis in the light of distribution, morphology and habitat than alternative hypotheses, which demand more complicated explanations.

As pointed out above (and in Appendix 1), hybrids link all sections of *Corymbia*, except that none are known to involve sections *Fundoria* or *Apteria*. *Angophora* is not linked with *Corymbia* by hybridism. Moreover, not only are there no hybrids between either of these genera and any member of the non-bloodwood eucalypt assemblage ('*Eucalyptus* clade'), but the only hybrid links known between any of the members of that assemblage treated separately in our analyses or discussions are of *Idiogenes* with *Monocalyptus* (Johnson & Blaxell unpublished) and of *Symphyomyrtus* sensu stricto with *Tingleria* and *Aenigmataria* (L.D. Pryor, pers. comm.). This bears on the unity of *Corymbia* and the contrasting diversity and separation of components of the '*Eucalyptus* clade', although it must, of course, be considered in conjunction with other relevant matters.

1.12. Taxon codes

In previous papers of this series we have omitted alphabetic taxon codes of the kind introduced by Pryor & Johnson (1971), pending full coverage of the genus or subgenus concerned. In this revision of the whole of *Corymbia*, updated codes can now be supplied. The letters apply in sequence to (1) immediate suprageneric level (here A for *Angophora* suballiance), (2) genus or subgenus (here C for *Corymbia*), (3) section, (4) series, (5) subseries, (6) species, (7) subspecies if any. In the case of subseries a dummy repeat letter is used where this category is omitted. See Appendix 3 for listing.

2. Taxonomy

Corymbia *K.D. Hill & L.A.S. Johnson*, **gen. nov.** (AC)

Genus ex affinitate *Angophorae*; trichomata si praesentia unicellularia muris tenuibus apicibus rotundatis; glandulae setiformes in partibus juvenilibus praesentes cellulis terminalibus 4 micropapillis ornatis; vasa xylematis solitaria; inflorescentiae compositae anthotelicae vel anauxotelicae, terminales vel laterales in ramulis vegetativis; calyx calyptriformis; petala libera et tunc plusminusve ad calycem adhaerentia vel corolla calyptriformis; capsula in hypanthio valde inclusa; discus fructus depressus; cotyledones in embryone plicati sectione *Blakearia* excepta.

Type species: *Corymbia gummifera* (Gaertner) K.D. Hill & L.A.S. Johnson

Eucalyptus subseries *Corymbosae* Bentham, Fl. Austral. 3: 198, 253 (1867). Type: *Eucalyptus gummifera* (Gaertner) Hochr., lectotype designated by Blake (1953). *Eucalyptus* series *Corymbosae* Blakely, Key Eucalypts: 15 (1934); Blake, Austral. J. Bot. 1: 229 (1953).

Type: *Eucalyptus dichromophloia* F. Muell. was designated as lectotype by Chippendale (1988), who was misled by Blakely's invalid use of '*Corymbosae* (*Non-Peltatae*)' and '*Corymbosae–Peltatae*'. The names are best forgotten.

Generally trees; bark persistent, shortly fibrous-flaky, parting in small polygons, or smooth, excorticating in polygonal flakes or short strips (except in *C. jacobsiana* (section *Fundoria*)). Juvenile leaves opposite for few nodes (many nodes in series *Ferrugineae*), sometimes peltate, with single-celled simple trichomes arising from undifferentiated epidermis, and bristle-glands. Adult leaves disjunct, bristle-free (rarely opposite and with trichomes and bristle-glands). Lateral veins of adult leaves (except in neotenic forms) closely-spaced, branched, oblique, intramarginal vein close to the margin but usually distinct. Conflorescences anauxotelic or anthotelic, expanded terminal or lateral panicles or thyrsoids, sometimes metabotryoids, often extensively branched, with unit usually 7-flowered (occasionally 3-flowered) umbellasters. Oil ducts present in ovary and nectary (Carr & Carr 1969). Perianth 5–4-merous (flexible), carpels usually 3, sometimes varying in individual flowers to 4 or more rarely 2, or usually 4 in section *Rufaria*. Calyx calyptriform, persistent to anthesis, or caducous; corolla of ± free petals and ± adherent to calyx, or calyptriform. Petals (at least in primordia) differentiated into claw and limb. Stamens all fertile; anthers oblong to oblong-obovate, dorsifixed, versatile, dehiscing by parallel slits. Stigma shaggy or tapered, lobed or not lobed, with short or long papillae. Cotyledons reniform, relatively large, folded in embryo (not folded in section *Blakearia*). Ovules hemipterous, not regularly arranged in rows on the placenta. Ovulodes present. Inner integument partially resorbed. Seeds laterally or dorsiventrally compressed, in some groups with a terminal wing; hilum subterminal or ventral. Fruits medium-sized to large, urceolate to globular; capsule deeply sunken in the hypanthium, valves enclosed.

Diagnosis: Unicellular thin-walled hairs and frequently complex bristle-glands regularly present on juvenile shoots; bristle-gland cap cells 4, ornamented with micropapillae; xylem vessels solitary (Ingle & Dadswell 1953); inflorescences compound, terminal or lateral; calyx calyptriform; petals *either* free but closely appressed to the calycine calyptra and shed with it *or* ± united and calyptriform; cotyledons folded in embryo (not folded in section *Blakearia*); capsule sunken in fruit, disc depressed.

The name is from the Latin *corymbium*, a corymb, recalling the epithet *Corymbosae* used in subsectional or sectional rank under *Eucalyptus* by earlier authors and the name *E. corymbosa*, a long-standing synonym for the type species. In species with the plesiomorphic condition, inflorescences are corymbiform, though not corymbs in the precise sense.

Keys

The following keys are not synoptic, but identificatory.

Key to sections

Persistence of the calycine calyptra creates the primary, or most easily recognised, dichotomy in the infrageneric groupings recognised within *Corymbia*. Differences in stigma micromorphology correlate completely with this dichotomy. However, for practical reasons, the primary division in the following key is between dorsiventrally and bilaterally compressed seeds, with corresponding differences in chaff (sterile-'seed') morphology, blocky and linear respectively.

1 Seeds laterally compressed; stigma shaggy with long papillae .... Section ACA **Rufaria**

1* Seeds dorsiventrally compressed; stigma shaggy or tapered

2 Petals free; stigma shaggy with long papillae

3 Bark long-fibrous with thin included scales; juvenile leaves subsessile, non-peltate .... Section ACE **Fundoria**

3* Bark short-fibrous, tessellated; juvenile leaves long-petiolate, peltate .... Section ACI **Apteria**

2* Petals fused into a calyptra; stigma with short papillae or smooth

4 Sepaline calyptra shedding shortly before anthesis; stigma with short papillae .... Section ACS **Politaria**

4* Sepaline calyptra shedding well before anthesis; stigma smooth

5 Fruits woody; juvenile leaves petiolate

6 Inner calyptra thickened, enclosing style-tip; rough bark persistent on trunk and limbs .... Section ACO **Ochraria**

6* Inner calyptra not thickened, not enclosing style-tip; bark smooth and deciduous on upper trunk and branches .... Section ACQ **Cadagaria**

5* Fruits 'papery' (lacking secondary thickening); juvenile leaves sessile .... Section ACU **Blakearia**

Key to the species

1 Fruits woody, heavily thickened

2 Outer calyptra persistent to, or (in section *Politaria*) almost to, anthesis

3 Adult leaves disjunct, never setose

4 Adult leaves distinctly discolorous .... **Group 1**
(sections *Fundoria* and *Apteria* and parts of section *Rufaria*)

4* Adult leaves concolorous or almost so .... **Group 2**
(section *Rufaria* series *Dichromophloiae*, *Collinae*, *Cliftonianae* and section *Politaria*)

3* Adult leaves opposite (*neotenous*), frequently setose .... **Group 3** (series *Ferrugineae*)

2* Outer calyptra shed well before anthesis .... **Group 4** (sections *Cadagaria* and *Ochraria*)

1* Fruits fragile, slightly thickened ('paper fruits') .... **Group 5** (section *Blakearia*)

Group 1. Adult leaves disjunct, discolorous, bristle-free (sections *Fundoria* and *Apteria* and part of section *Rufaria*).

1 Seeds not terminally winged

2 Seeds laterally compressed

3 Seeds black .... 6. **C. calophylla** (ACIBBY)

3* Seeds brown or red-brown

4 Fruits 12–30 mm diam.; seeds brown to dark brown; Western Australian species

5 Adult leaves dull, moderately acuminate .... 4. **C. haematoxylon** (ACIBBE)

5* Adult leaves glossy, with a long acuminate 'drip-tip'-like point .... 5. **C. chlorolampra** (ACIBBL)

4* Fruits 11–15 mm diam.; seeds red-brown; Eastern Australian species .... 3. **C. gummifera** (ACIBBA)

2* Seeds dorsiventrally compressed

6 Juvenile leaves ovate or elliptical, peltate .... 2. **C. trachyphloia** (ACETTA)

6* Juvenile leaves linear, not peltate .... 1. **C. jacobsiana** (ACAJJA)

1* Seeds terminally winged

7 Juvenile leaves setose for many nodes; with simple hairs

8 Fruits not flared; pedicels more than 10 mm long .... 30. **C. bleeseri** (ACISSB)

8* Fruits usually flared; pedicels mostly less than 10 mm long

9 Bark persistent on most branches; adult leaves amphistomatic

10 Adult leaves glossy; tall straight trees .... 7. **C. nesophila** (ACIDDN)

10* Adult leaves dull; small spreading trees .... 21. **C. arenaria** (ACIQQU)

9* Bark persistent on trunk only; adult leaves hypostomatic .... 20. **C. arnhemensis** (ACIQQI)

7* Juvenile leaves becoming non-setose early; lacking simple hairs

11 Juvenile leaves ovate to narrow-elliptical

12 Fruits sessile .... 8. **C. abergiana** (ACIEEA)

12* Fruits pedicellate

13 Adult leaves amphistomatic (except sometimes in *C. polycarpa* and *E. ligans*)

14 Fruits more than twice as long as broad .... 12. **C. polycarpa** (ACILLA)

14* Fruits less than twice as long as broad

15 Fruits less than 13 mm diam.

16 Bark persistent to small branches .... 16. **C. ligans** (ACILLK)

16* Bark smooth on upper trunk and branches .... 33. **C. dichomophloia** (ACIVEA)

15* Fruits more than 14 mm diam. .... 19. **C. porrecta** (ACINNO)

13* Adult leaves hypostomatic

17 Buds not scurfy

18 Fruits large (>20 mm diam.) .... 9. **C. ficifolia** (ACIFFI)

18* Fruits smaller (<19 mm diam.)

19 Fruits ovoid, thick-rimmed, small (10–21 mm long, 8–16 mm diam.) .... 10. **C. intermedia** (ACIGGI)

19* Fruits urceolate, with a thin rim, larger (18–28 mm long, 14–19 mm diam.) .... 22. **C. rhodops** (ACIRAR)

17* Buds scurfy

20 Fruits very large (>20 mm diam.) .... 11. **C. ptychocarpa** (ACIJJO)

20* Fruits not as large (<20 mm diam.)

21 Buds large (12–15 mm long, 7–9 mm diam.) .... 18. **C. plena** (ACILLP)

21* Buds smaller (<12 mm long, <7 mm diam.)

22 Pedicels long (8–18 mm); fruits large (11–20 mm diam.) .... 13. **C. novoguinensis** (ACILLD)

22* Pedicels short (3–10 mm); fruits smaller (10–16 mm diam.)

23 Leaves with ± evident oil glands

24 Leaves thin-textured; oil glands in lower mesophyll only .... 14. **C. clarksoniana** (ACILLE)

24* Leaves moderately thick; oil glands in both upper and lower mesophyll .... 15. **C. maritima** (ACILLJ)

23* Leaves with no or few evident oil glands .... 17. **C. dolichocarpa** (ACILLO)

11* Juvenile leaves linear or narrowly oblong

25 Juvenile leaves non-setose after node 5

26 Fruits mostly smooth (or very lightly scurfy or scaly)

27 Branchlets smooth

28 Fruits not flared; pedicel medium thick, short to long .... 25. **C. brachycarpa** (ACIRBY)

28*Fruits flared; pedicel thin, long .... 26. **C. clandestina** (ACIRBZ)

27*Bark fully persistent (fruits usually flared) .... 16. **C. ligans** (ACILLK)

26*Fruits scurfy or scaly

29 Adult leaves glossy; fruits 12–15 mm diam. .... 23. **C. xanthope** (ACIRBA)

29*Adult leaves ± dull; fruits 13–22 mm diam .... 24. **C. hendersonii** (ACIRBE)

25*Juvenile leaves setose with bristle-glands beyond node 10 (no simple hairs)

30 Fruits scaly

31 Adult leaves highly glossy .... 29. **C. lamprophylla** (ACIRSL)

31*Adult leaves dull to semi-glossy .... 28. **C. stockeri** (ACIRSK)

30*Fruits smooth .... 27. **C. hylandii** (ACIRSH)

Group 2. Adult leaves disjunct, concolorous, bristle-free (section *Rufaria* series *Collinae*, *Cliftonianae*, *Dichromophloiae* and section *Politaria*). See also unkeyed spp.: 50. **C. opacula** (ACIVJO) (intermediate between *C. drysdalensis* and *C. opaca*) and 57. **C. pedimontana** (ACIVRI) (intermediate between *C. dampieri* and *C. opaca*).

1 Juvenile leaves setose with bristle-glands and bearing simple hairs

2 Leaves very glossy

3 New growth silver-white; buds scurfy .... 31. **C. collina** (ACISSO)

3* New growth green; buds not scurfy

4 Pedicels 10–15 mm long; fruits not flared .... 30. **C. bleeseri** (ACISSB)

4* Pedicels 5–12 mm long; fruits usually flared

5 Bark persistent to most branches .... 7. **C. nesophila** (ACIDDN)

5* Bark persistent on trunk only .... 32. **C. oocarpa** (ACIVBO)

2* Leaves ± dull to semi-glossy .... 58. **C. cliftoniana** (ACIWWK)

1* Juvenile leaves setose with bristle-glands (or mostly bristle-free), simple hairs lacking

6 Fruits large (>14 mm diam.)

7 Adult leaves broad-lanceolate or broader

8 Bark wholly persistent .... 19. **C. porrecta** (ACINNO)

8* Bark shedding on branches

9 Pedicel slender; leaves and fruits glossy .... 54. **C. byrnesii** (ACIVOG)

9* Pedicel thick; leaves and fruits ± dull

10 Pedicel long (5–17 mm); adult leaves ovate .... 56. **C. foelscheana** (ACIVOL)

10* Pedicel short (mostly < 5 mm); adult leaves broad-lanceolate .... 55. **C. curtipes** (ACIVOK)

7* Adult leaves lanceolate or narrower

11 Fruits globular; buds not scurfy

12 Pedicel thick (>2 mm) .... 44. **C. chippendalei** (ACIVIJ)

12* Pedicel slender (<2 mm) .... 42. **C. eremaea** (ACIVIB)

11* Fruits ± urceolate; buds scurfy

13 Inflorescence branches thickened

14 Buds broad (9–13 mm diam.); adult leaves slightly discolorous .... 49. **C. terminalis** (ACIVIT)

14* Buds slender (6–8 mm diam.); adult leaves fully concolorous .... 48. **C. tumescens** (ACIVIS)

13* Inflorescence branches not thickened

15 Pedicels more than 8 mm long, gradually expanding into the hypanthium .... 47. **C. opaca** (ACIVIO)

15* Pedicels less than 7 mm long, sharply demarcated from the hypanthium .... 46. **C. semiclara** (ACIVIM)

6* Fruits smaller (<14 mm diam.)

16 Adult leaves broad-lanceolate or broader

17 Leaves rounded .... 51. **C. latifolia** (ACIVOA)

17* Leaves acute

18* Fruits small (7–10 mm diam.) .... 33. **C. dichromophloia** (ACIVEA)

18 Fruits larger (>10 mm diam.)

19 Fruits 16–20 mm long; adult leaves mostly ovate .... 53. **C. greeniana** (ACIVOE)

19* Fruits 13–17 mm long; adult leaves mostly broad-lanceolate .... 52. **C. dampieri** (ACIVOD)

16* Adult leaves lanceolate or narrower

20 Trunk mostly smooth

21 Umbellasters 7-flowered

22 Young shoot-tips white .... 34. **C. drysdalensis** (ACIVED)

22* Young shoot-tips green

23 Adult leaves slightly discolorous, sub-glossy above

24 Fruits small (7–10 mm diam.) .... 33. **C. dichromophloia** (ACIVEA)

24*Fruits larger (>10 mm diam.) .... 52. **C. dampieri** (ACIVOD)

23*Adult leaves concolorous, dull .... 35. **C. capricornia** (ACIVEF)

21*Umbellasters 3-flowered

25 Leaves thick (0.24–0.45 mm), coarsely veined, buds and fruits on thick pedicels .... 86. **C. henryi** (ACSAAX)

25*Leaves thin to medium (0.15–0.32 mm), finely veined, buds and fruits on slender to medium pedicels

26 Adult leaves 0.24–0.34 mm thick, length:breadth ratio mostly 2–7, juvenile leaves ovate .... 85. **C. maculata** (ACSAAS)

26*Adult leaves 0.15–0.25 mm thick, length:breadth ratio mostly 5–15, juvenile leaves narrow-ovate

27 Leaves not lemon-scented .... 84. **C. variegata** (ACSAAL)

27*Leaves distinctly lemon-scented .... 83. **C. citriodora** (ACSAAC)

20*Trunk mostly not smooth

28 Bark distinctly rusty-red

29 Adult leaves very narrow (mostly <15 mm wide) .... 41. **C. porphyritica** (ACIVET)

29*Adult leaves not very narrow (>15 mm wide)

30 Juvenile leaves orbicular .... 36. **C. umbonata** (ACIVEJ)

30*Juvenile leaves lanceolate

31 Fruits small (<10 mm diam)

32 Adult leaves thin .... 40. **C. ellipsoidea** (ACIVES)

32*Adult leaves thick .... 38. **C. pocillum** (ACIVEP)

31*Fruits medium-sized (often >10 mm diam)

33 Bark thin, orange-brown

34 Bark finely fibrous and platy, persistent to lower branches; adult leaves dull .... 37. **C. rubens** (ACIVEK)

34*Bark coarsely scaly, persistent only to upper trunk; adult leaves often sub-glossy .... 52. **C. dampieri** (ACIVOD)

33*Bark thick, dark red-brown .... 39. **C. erythrophloia** (ACIVER)

28*Bark not distinctly rusty-red (except sometimes in *C. hammersleyana*)

35 Juvenile leaves narrow-lanceolate or linear

36 Fruit evenly contracted to rim, foliage drooping .... 43. **C. lenziana** (ACIVIG)

36*Fruit with a definite neck below rim, foliage not pronouncedly drooping .... 42. **C. eremaea** (ACIVIB)

35*Juvenile leaves broad-lanceolate or broader .... 45. **C. hamersleyana** (ACIVIL)

Group 3. Apparently adult leaves opposite, frequently setose (series Ferrugineae).

1 Pinnate venation interrupted in adult leaves

2 Adult leaves setose

3 Vestiture ferruginous .... 59. **C. ferruginea** (ACIXAE)

3* Vestiture not ferruginous .... 68. **C. papillosa** (ACIXUA)

2* Adult leaves not or scarcely setose .... 60. **C. abbreviata** (ACIXAV)

1* Venation regularly pinnate in adult leaves

4 Adult leaves perfoliate .... 61. **C. cadophora** (ACIXEC)

4* Adult leaves not perfoliate

5 Adult leaves not falcate

6 Fruits large (>15 mm diam.)

7 Fruits urceolate, constricted below rim

8 Umbellasters 3-flowered .... 65. **C. dunlopiana** (ACIXOL)

8* Umbellasters 7-flowered

9 Adult leaves large (6–15 cm long, 30–65 mm wide), chartaceous .... 64. **C. chartacea** (ACIXOJ)

9* Adult leaves smaller (4–10 cm long, 20–46 mm wide), coriaceous .... 67. **C. pachycarpa** (ACIXOY)

7* Fruits ± globular or ovoid

10 Fruits not scaly, leaves not setose ..... 63. **C. sphaerica** (ACIXOE)

10*Fruits scaly, leaves setose .... 66. **C. setosa** (ACIXOS)

6* Fruits small (<15 mm diam.)

11 Bristle-glands densely papillose .... 68. **C. papillosa** (ACIXUA)

11*Bristle-glands not densely papillose

12 Fruits small (9–14 mm diam.); if fruits more than 12 mm diam., then pedicels less than4 mm long .... 69. **C. deserticola** (ACIXUD)

12*Fruits larger (13–23 mm diam.); if fruits less than15 mm diam., then pedicels more than 5 mm long .... 66. **C. setosa** (ACIXOS)

5* Adult leaves falcate, at least towards the ends .... 62. **C. zygophylla** (ACIXOA)

Group 4. Outer calyptra shed well before anthesis (sections *Ochraria* and *Cadagaria*).

1 Bark smooth on most of trunk .... 82. **C. torelliana** (ACQUUT)

1* Bark persistent on trunk and larger branches

2 Mature canopy containing at least some peltate setose intermediate leaves

3 Canopy comprising both intermediate and non-setose adult leaves

4 Calyptra broader than hypanthium; fruits more than 19 mm long .... 77. C. **watsoniana** (ACOYYO)

4* Calyptra and hypanthium of same width; fruits 11–14 mm long .... 78. C. **dimorpha** (ACOYYQ)

3* Canopy consisting only or predominantly of scabrid or setose intermediate leaves

5 Leaves broadly ovate or broader, 6–9 cm wide; petioles more than 15 mm long .... 79. C. **peltata** (ACOYYR)

5* Leaves narrowly ovate or lanceolate, 2–4 cm wide; petioles less than 15 mm long .... 80. C. **scabrida** (ACOYYS)

2* Mature canopy comprising only non-setose non-peltate adult leaves

6 Adult and intermediate leaves green, ± glossy

7 Adult leaves distinctly discolorous .... 70. C. **leptoloma** (ACOYYA)

7* Adult leaves concolorous

8 Fruits less than 12 mm long .... 73. C. **bunites** (ACOYYG)

8* Fruits more than 12 mm long

9 Buds often whitish; pedicels 0–2 mm long .... 74. C. **aureola**(ACOYYJ)

9* Buds never whitish; pedicels 3–6 mm long .... 72. C. **bloxsomei** (ACOYYE)

6* Adult and intermediate leaves grey-green, dull

10 Fruits more than 19 mm long; calyptra broader than hypanthium .... 77. C. **watsoniana** (ACOYYO)

10* Fruits less than 19 mm long; calyptra and hypanthium of same width

11 Intermediate leaves peltate for many nodes

12 Adult leaves falcate; fruits 14–18 mm long

13 Pedicels 0–2 mm long; NSW species .... 81. C. **eximia** (ACOYYX)

13* Pedicels 1–5 mm long; Qld species .... 76. C. **catenaria** (ACOYYN)

12* Adult leaves not falcate; fruits 9–15 mm long .... 71. C. **leichhardtii** (ACOYYC)

11* Intermediate leaves either not peltate or peltate for few early nodes

14 Adult leaves less than 25 mm wide, petioles 10–20 mm long; juvenile leaves narrow-lanceolate ...... 73. C. **bunites** (ACOYYG)

14* Adult leaves 25–40 mm wide, petioles 20–38 mm long; juvenile leaves broad-lanceolate .... 75. C. **petalophylla** (ACOYYL)

Group 5. Fruits not thickened (section *Blakearia*).

1 Intermediate internodes of inflorescence expanded

2 Intermediate leaves setose with bristle-glands bearing simple hairs; adult-leaf petioles 1–5 mm long .... 101. C. **chillagoensis** (ACUKKA)

2* Intermediate-leaf bristle-glands absent or, if present, not bearing simple hairs; adult-leaf petioles mostly more than 5 mm long

3 Well-developed, distinct finely tessellated stocking present

4 Intermediate leaves narrow-lanceolate, non-setose; adult leaves with very fine ultimate reticulum .... 87. C. **tessellaris** (ACUAAT)

4* Intermediate leaves broad-lanceolate, setose; adult-leaf ultimate reticulum not very fine .... 99. C. **polysciada** (ACUHHA)

3* Stocking usually absent or indistinct and loosely scaly (if present and finely tessellated then short)

5 Adult leaves predominantly broad-lanceolate (if narrow-lanceolate then trunk with some loosely scaly bark)

6 Intermediate leaves persisting setose; pedicels distinctly extended (mostly more than 10 mm long); trunk usually with some loose scaly bark .... 92. C. **clavigera** (ACUDDL)

6* Intermediate leaves becoming non-setose early; pedicels not distinctly extended (< 8 mm long)

7 Early intermediate leaves cordate; adult petioles mostly less than 10 mm long, peduncles more than 9 mm long .... 88. C. **papuana** (ACUCCE)

7* Early intermediate leaves not cordate; adult petioles mostly more than 10 mm long, peduncles less than 9 mm long

8 Petioles more than 5 mm long; intermediate leaves non-setose

9 Petioles 8–16 mm long; peduncles 2–9 mm long; pedicels 2–5 mm long .... 89. C. **paracolpica** (ACUCCF)

9* Petioles 5–26 mm long; peduncles 2–4 mm long; pedicels 4–7 mm long .... 90. C. **arafurica** (ACUCCJ))

5* Adult leaves narrow-lanceolate .... 91. C. **bella** (ACUCCL)

1* Intermediate internodes of inflorescence condensed

9 Adult leaves broad-lanceolate or broader

10 Peduncles more than 10 mm long

11 Bristle glands bearing simple trichomes

12 Longest petioles less than 12 mm long; bark stocking absent or irregularly developed at base of trunk .... 97. C. **dendromerinx** (ACUIIF)

12* Longest petioles more than 14 mm long; bark stocking clearly defined, covering at least half of trunk .... 96. C. **karelgica** (ACUIID)

11* Bristle-glands not bearing simple trichomes

13 Adult-leaf petioles more than 6 mm long .... 93. **C. disjuncta** (ACUIIA)

13* Adult-leaf petioles less than 4 mm long

14 Adult leaves consistently setose .... 95. **C. confertiflora** (ACUIIC)

14* Adult leaves non-setose or almost so .... 94. **C. pauciseta** (ACUIIB)

10* Peduncles less than 6 mm long

15 Adult-leaf petioles more than 5 mm long

16 Pedicels more than 10 mm long ..... 112. **C. grandifolia** (ACUSSO)

16* Pedicels less than 6 mm long .... 111. **C. flavescens** (ACUSSL)

15* Adult-leaf petioles less than 3 mm long

17 Adult leaves apically rounded; fruits less than 6 mm diam.

18 Largest adult leaves less than 65 mm long, 35 mm wide, 0.40 mm or more thick; bark usually grey or pink .... 107. **C. aspera** (ACULLI)

18* Largest adult leaves more than 70 mm long, 40 mm wide, less than 0.35 mm thick; bark white .... 108. **C. punkapitensis** (ACULLP)

17* Adult leaves acute; fruits usually more than 6 mm diam. .... 105. **C. candida** (ACULLC)

9* Adult leaves lanceolate or narrower

19 Adult leaves glossy yellow-green

20 Some tessellated stocking present, if only at extreme base; juvenile leaves persistent, sometimes in crown .... 100. **C. torta** (ACUHHI)

20* Bark wholly smooth, no tessellated stocking even at extreme base; j juvenile leaves not persistent in crown

21 Adult leaves moderately glossy, fine venation not obscured; intermediate leaves usually more than 50 mm wide; bark usually grey or pink, occasionally white .... 109. **C. dallachiana** (ACUSSD)

21* Adult leaves extremely glossy, fine venation obscured; intermediate leaves usually less than 50 mm wide; bark white .... 110. **C. aparrerinja** (ACUSSU)

19* Adult leaves dull grey-green

22 Bristle-glands not bearing simple hairs

23 Adult-leaf petioles more than 6 mm long

24 Pedicels more than 7 mm long .... 98. **C. kombolgiensis** (ACUFFK)

24* Pedicels less than 5 mm long ...... 106. **C. ferriticola** (ACULLF)

23* Adult-leaf petioles less than 6 mm long .... 104. **C. blakei** (ACUKKO)

22* Bristle-glands bearing simple hairs

25 Peduncles 0–4 mm long

26 Pedicels more than 6 mm long .... 113. **C. paractia** (ACUTTO)

26* Pedicels less than 5 mm long .... 103. **C. inobvia** (ACUKKI)

25* Peduncles 4–12 mm long .... 102. **C. gilbertensis** (ACUKKG)

ACA Section **Fundoria**

Rhizomes present. Bark long-fibrous, flaky with 'micaceous' scales (thin glossy reddish or brown scales resembling mica in appearance), ± corky. Juvenile leaves linear, sessile, non-peltate, with bristle-glands and simple hairs. Adult leaves fully hypostomatic, with a hard, glossy cuticle on the upper (adaxial) surface. Inflorescence terminal or becoming infraterminal. Calyx calyptriform, persistent to anthesis. Petals free but adhering to and falling with the calycine calyptra. Style straight, base ± sunken, tip not engaged in calyptra. Stigma shaggy with long papillae. Columella present in open fruits. Seeds wingless, dorsiventrally compressed, elliptical, red-brown, smooth (seed coat not cracking), hilum ventral.

The sectional epithet is based on the Latin *fundus*, bottom, referring to the near-basal phylogenetic divergence of the section and also referring obliquely to a dog-Latin epithet jocosely suggested by the late Max Jacobs for the species he brought to notice, in relation to the perceived wretched nature of its habitat. The termination *-ria*, following a philologically appropriate vowel, is used to indicate sectional rank in the extracodical system introduced by Pryor & Johnson (1971).

This section and the following section (*Apteria*) have seed characters comparable with those of the yellow bloodwoods and related groups (*Ochraria* + *Politaria* + *Cadagaria*), but leaf-structure, calyx, corolla, style and stigma characters are comparable with those of the red bloodwoods. Sections *Fundoria*, *Apteria* and *Rufaria* (the red bloodwoods in the augmented sense) appear to represent a monophyletic group united by the persistent calycine calyptra (assuming this persistence is apomorphic) and the regular fine leaf venation with intrusive mesophyll fibres. The seeds also lack the fine regular cracking present in those of sections *Politaria*, *Cadagaria* and *Ochraria*, and of *Angophora*. This lack may be another synapomorphy shared by *Fundoria*, *Apteria* and *Rufaria*, and appearing homoplastically in *Blakearia*.

The long-fibrous bark character of this unispecific northern Australian section is unique within the *Angophora* clade (*Angophora* + *Corymbia*). The sessile juvenile leaves are also an infrequent occurrence. Juvenile leaves in series *Rhodopes* are somewhat similar, but are not fully sessile and lack the simple hairs. Those of *C. arnhemensis* are initially linear with simple hairs, but remain petiolate and quickly become oblong and ± peltate.

1. ACAJJA **Corymbia jacobsiana** *(Blakely) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus jacobsiana* Blakely, Key Eucalypts: 92 (1934).

Type citation: 'Dr. M. R. Jacobs, No. 90, July, 1933.'

Type: Northern Territory: 10 miles [16 km] W. of Pine Creek, *M.R. Jacobs 90*, July 1933 (holo NSW; iso BRI, CANB). Figured by Blake (1953), plate 23.

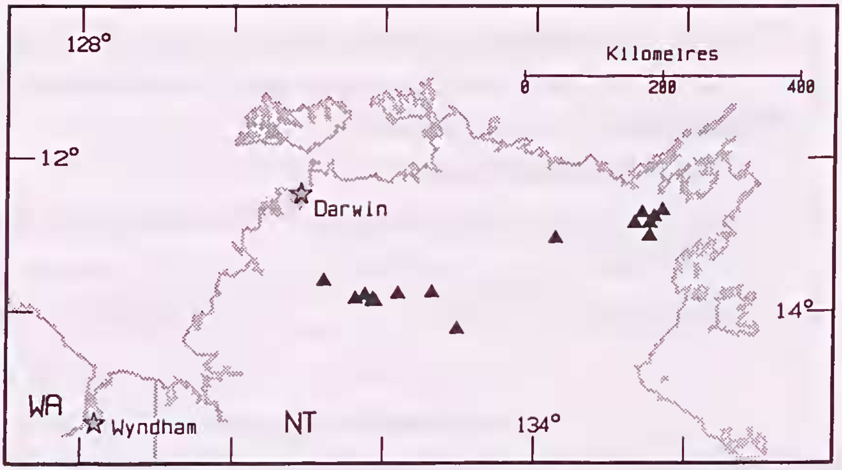

Fig. 18. Distribution of *C. jacobsiana*.

Tree to 15 m. *Rhizomes* present. *Bark* persistent throughout, long-fibrous with included glistening scales, yellow-brown to greyish, pale yellowish to pale brown on freshly broken surfaces. *Cotyledons* 6–8 mm long, 7–9 mm wide; *petioles* to 9 mm long. *Juvenile leaves* opposite, setose for about 20–25 nodes with bristle-glands and also with a dense indumentum of simple hairs, linear to narrow-oblong, acute, not peltate, to 9 cm long, to 10 mm wide; *petioles* 1–3 mm long. *Intermediate leaves* disjunct, bristle-free but with simple hairs beneath, linear to lanceolate, acute, to 8 cm long, to 10 mm wide; *petioles* 2–5 mm long. *Adult leaves* disjunct, strongly discolorous, wholly hypostomatic, very glossy above, narrow-lanceolate to broad-lanceolate, acuminate, 5–11 cm long, 7–21 mm wide; *petioles* 5–12 mm long; *intramarginal vein* distinct; *oil glands* small, frequent. *Umbellasters* 7-flowered; *peduncles* 5–10 mm long; *pedicels* 3–5 mm long. *Mature buds* globular to broadly clavate, not scurfy, 1–2 mm long, 1–2 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, patelliform or shallowly hemispherical, sometimes minutely apiculate. *Fruits* elongate-ovoid, sometimes urceolate and apically flared, smooth to brown-scaly, 7–10 mm long, 5–8 mm diam.; 3-locular; *disc* 1–2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, c. 4 mm long, c. 2 mm wide.

Flowering: Not recorded.

Scattered, in often small populations on shallow soils on sandstone ridges or rises or lateritic residuals in the north of the Northern Territory. Several populations are in the Arnhem Land region and further exploration may extend that range (Fig. 18).

Conservation status: Although scattered in distribution, considerable populations exist in remote regions that are secure from disturbance; this species is not considered to be at risk.

Selected specimens (from 20 examined): Northern Territory: Arnhem Land, 22 km W of Lake Evella turnoff (about 12°40'S 135°40'E), *Symon 7827*, 22 June 1972 (AD ex ADW, NSW); 14.2 km E of Badalngarrmirri Creek, *Hill 3934 & Stanberg*, 26 Aug 1991 (NSW, BRI, CANB, DNA, MEL); 80 km NNW on Maningrida road from turnoff on Gove road (13°02'S 134°15'E), *Symon 7850*, 24 June 1972 (AD ex ADW, CANB, NSW); 14.2 km N of Pine Creek, on mesa c. 0.7 km W of Stuart Highway, *Hill 913, Johnson & Benson*, 20 July 1984 (NSW); 20 miles [32 km] SE of El Sharana, *Story 8194*, 2 Mar 1973 (CANB, B, BRI, DNA, K, L, MEL, NSW, PERTH, US); c. 25 [40 km] miles NNE of Maranboy Police Station, *Lazarides & Adams 14*, 3 Mar 1965 (CANB, BRI, DNA, E, K, L, MEL, NSW, US).

ACE Section **Apteria**

Rhizomes present. Bark fully persistent, loosely corky, shortly fibrous, yellow-brown, parting in polygonal scales; with enlarged phloem fibres. Juvenile leaves lanceolate to ovate, petiolate, peltate, with simple hairs and bristle-glands. Adult leaves hypostomatic or amphistomatic. Inflorescence terminal or becoming infraterminal. Calyx calyptriform, persistent to anthesis. Petals free but adhering to and falling with the calycine calyptra. Style-base sunken. Columella present in open fruits. Seeds wingless, elliptical, dorsiventrally flattened, dorsally keeled, smooth (seed coat not cracking), red-brown; hilum ventral. Stigma shaggy with long papillae.

The sectional epithet is derived from the Greek, *a-*, not, and *pteron*, a wing, referring to the wingless seeds that differentiate the section from *Rufaria*, with which it was formerly associated. The euphonic contraction from the ending *-aria* in this case is deliberate.

A single species, with its three subspecies all in eastern Australia, constitutes this section. The softly flaky yellow-brown bark approaches that of the yellow bloodwoods (section *Ochraria*), as do the dorsally compressed glossy red seeds. The seed character, however, is a shared plesiomorphy, and the bark condition is equivocal, being approached also in some red bloodwoods such as *C. xanthope*. Apomorphic character-states of the seed coat and of bark phloem fibres, as well as the possibly apomorphic persistent calycine calyptra, group *Apteria* with section *Rufaria*, and the plesiomorphic stigma state also is shared with that section, the true red bloodwoods.

2. ACETTA **Corymbia trachyphloia** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus trachyphloia* F. Muell., J. Linn. Soc., Bot. 3: 90 (1859).

Type citation: 'Hab. In collibus ad flumen Burnett. Anth. Sept. Oct.'.

Type: Queensland: on hills near the Burnett River, *F. Mueller* (holo MEL; iso BM, K).

Tree to 25 m, often less than 12 m, less frequently of mallee-like form. *Rhizomes* present. *Bark* persistent to smaller branches, light grey to yellowish, flaky, tessellated and vertically fissured, soft and ± spongy, pale yellow-brown on freshly broken surfaces. *Cotyledons* 8–11 mm long, 10–13 mm wide; *petioles* to 8 mm long. *Juvenile leaves* opposite, setose with bristle-glands and bearing simple hairs, lanceolate to oblong, mucronate, peltate after about node 5, to 10 cm long, to 30 mm wide; *petioles* to 6 mm long. *Intermediate leaves* disjunct, setose with bristle-glands and bearing simple hairs, or becoming bristle-free and glabrous early, apiculate, lanceolate to ovate or oblong, to 20 cm long, to 60 mm wide; *petioles* to 30 mm long. *Adult leaves* disjunct, discolorous, amphistomatic or hypostomatic, lanceolate to broad-lanceolate, more or less falcate, acute or acuminate, 7–14 cm long, 9–40 mm wide; *petioles* 10–20 mm long; *intramarginal vein* distinct; oil glands sparse or not evident. *Umbellasters* 7-flowered; *peduncles* 5–13 mm long; *pedicels* 2–7 mm long. *Mature buds* pyriform, rarely ovoid, not scurfy, 3–8 mm long, 2–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, patelliform or shallowly hemispherical, sometimes minutely apiculate. *Fruits* ovoid-urceolate, often flared, smooth to lenticellate, 6–10 mm long, 3–8 mm diam.; capsule 3-locular (rarely 4); *disc* 1–2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, c. 3 mm long, c. 2 mm wide.

A widespread and locally abundant species, extending from Mt Mulligan (north-west of Mareeba) in Queensland south to the Goulburn River valley in New South Wales (Fig. 19).

Three geographic subspecies are recognised.

1 Adult leaves hypostomatic .... 2A. subsp. **trachyphloia**

1* Adult leaves amphistomatic

2 Intermediate leaves lanceolate, < 25 mm wide ... 2B. subsp. **amphistomatica**

2* Intermediate leaves broad-lanceolate, > 25 mm wide ... 2C. subsp. **carnarvonica**

2A. ACETTAH Corymbia trachyphloia *(F. Muell.) K.D. Hill & L.A.S. Johnson* subsp. **trachyphloia**

= *E. trachyphloia* F. Muell. forma *fruticosa* Bailey, Queensland Agric. J. 25: 9 (1910).

Type citation: '... observed on the Glasshouse Mountains – ...'

Type: Queensland: top of Glasshouse Mountains, *F.M. Bailey*, July 1879 (holo BRI). Maiden (Crit. Rev. Eucalyptus 5: 43, 1920) included this dwarfed form in *E. trachyphloia*, a treatment subsequently generally followed.

Juvenile leaves opposite, setose with bristle-glands and bearing simple hairs, lanceolate to oblong, mucronate, peltate after about node 5, to 5 cm long, to 15 mm wide; *petioles* to 4 mm long. *Intermediate leaves* disjunct, setose beyond node 20, apiculate, ovate, becoming lanceolate to narrow-oblong, to 10 cm long, to 22 mm wide; *petioles* to 12 mm long. *Adult leaves* discolorous, hypostomatic, lanceolate, 7–12 cm long, 9–24(–30) mm wide; *petioles* 10–18 mm long. *Peduncles* 5–13 mm long; *pedicels* 2–6 mm long. *Mature buds* 3–5 mm long, 2–3 mm diam. *Fruits* 6–10 mm long, 5–8 mm diam. Fig. 20.

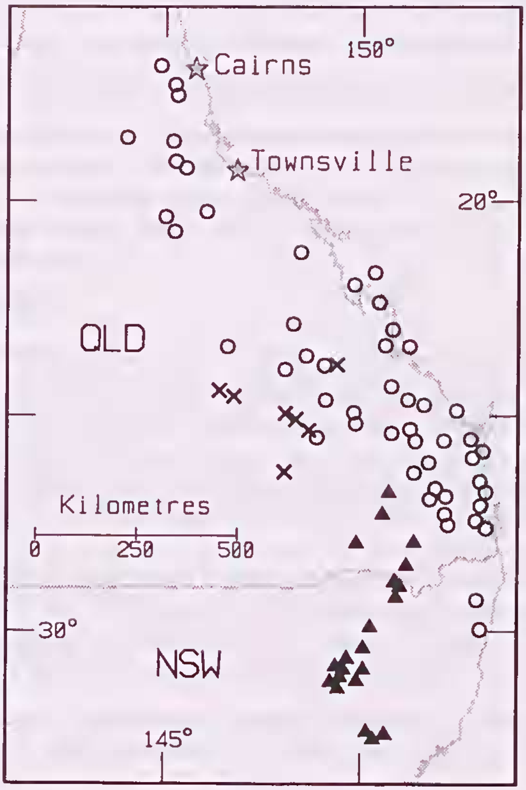

Fig. 19. Distribution of *C. trachyphloia* subsp. *trachyphloia* (circle), subsp. *amphistomatica* (triangle), subsp. *carnarvonica* (cross).

Fig. 20. C. *trachyphloia*: subsp. *trachyphloia*. a, late juvenile leaves. b, adult leaves, inflorescences, buds and flowers. c, fruits. subsp. *amphistomatica*. d, late juvenile leaves. e, adult leaves, inflorescence and fruits. subsp. *carnarvonica*. f, intermediate leaf. g, adult leaves and buds. h, fruits. (a, b, c from *Hill 3598 & Stanberg*, d, e from *Boorman NSW 302046*, f from *Hill 1329*, g from *Weston 1560 & Richards*, h from *Bean 773*). Scale bars = 1 cm.

Flowering: Jan–Mar(–Apr).

Distinguished by the hypostomatic adult leaves. Adult leaves are generally small, and fruits frequently display a thinner rim than in the other subspecies. The hypostomatic condition is probably plesiomorphic.

This subspecies is predominantly eastern in distribution, from Mt Mulligan to south of Grafton, extending west in a zone running north of subsp. *carnarvonica* (Fig. 19). Always on low-nutrient substrates (usually siliceous, but recorded from serpentinites on South Percy Island), often on shallow or skeletal soils. It is sometimes mallee-like in harsher sites, and is known to regenerate from rhizomes.

Some overlap with subsp. *carnarvonica* occurs on the Blackdown Tableland and south-west of there. No intermediate forms are known, but the contact zones have not been thoroughly searched for these.

Conservation status: Widespread and locally abundant, not considered to be at risk.

Selected specimens (from 83 examined): Queensland: Mt Mulligan, *Clarkson 5852*, 16 Apr 1985 (BRI, CANB, NSW, QRS); near Mt Misery, *Hyland 8034*, 16 Feb 1975 (QRS, CANB, NSW); 30 miles [50 km] E of Forsayth, *Johnson & Pryor*, 21 Oct 1964 (NSW 301879); 27 km NW of Clarke River on Charters Towers to Lynd Junction road, *Benson 811*, 16 June 1974 (NSW); Burra Range, near railway crossing, *Jackes*, 3 July 1984 (NSW); 16.6 km from Eungella along dam road, then 2.6 km along track to WSW, *Martensz 1103*, 30 Aug 1976 (CANB, NSW); 21.2 km N of Clareview turnoff on Highway 1, *Hill 3598 & Stanberg*, 6 Dec 1988 (NSW, BRI, CANB); South Percy Island, *Batianoff 11501 et al.*, 27 Oct 1989 (BRI, CANB, LAE, NSW, PRE, IBSC); c. 19 km SE of Byfield, *Anderson 3892*, 29 Nov 1984 (BRI, NSW); 6 miles [10 km] ENE of 'Monkland' station, *Adams 1329*, 1 Oct 1964 (CANB, NSW); Blackdown Tableland, *Henderson 709, Andrews & Sharpe*, 20 Apr 1971 (BRI, NSW); Little St Peter, upper slopes, *Wallace 83066 & Hind*, 23 Aug 1983 (NSW); Bundaberg, *Maiden*, Mar 1909 (NSW); Lookout, Isla Gorge Natl Park, *Boyland 8019*, 11 Sep 1979 (BRI, CAL, CANB, MO, NSW, SAR); plateau S of 'Wallaroo' on Injune-Rolleston road, *Bean 762*, 17 Feb 1988 (NSW); Beerwah, *Johnson*, 26 May 1951 (NSW302016); near Mt Gravatt, *Melville 3537 & Blake*, 30 Mar 1953 (K, NSW).

New South Wales: North Coast: 6 miles [10 km] W of Camira Creek, NW of Grafton, *Turner*, 1955 (NSW); near McGills road, 30 km S of Grafton, *Bean 2431*, 9 Oct 1990 (BRI, CANB, NSW).

2B. ACETTAM **Corymbia trachyphloia** *(F. Muell.) K.D. Hill & L.A.S. Johnson* subsp. **amphistomatica** K.D. Hill & L.A.S. Johnson, **subsp. nov.**

Inter subspecies *C. trachyphloiae* combinatione characterum distinguitur: folia intermedia lanceolata vel oblonga; folia adulta amphistomatica lanceolata (saepissime minus quam 25 mm lata).

Type: New South Wales: Central Western Slopes: 16.5 km from Merriwa on Gungal road, *K.D. Hill 2777, L.A.S. Johnson & P.H. Weston*, 21 Oct 1987 (holo NSW; iso CBG, MEL, PERTH).

Juvenile leaves opposite, setose with bristle-glands and bearing simple hairs, lanceolate to oblong, mucronate, peltate after about node 5, to 8 cm long, to 20 mm wide; *petioles* to 6 mm long. *Intermediate leaves* disjunct, setose to c. node 15–20, apiculate, lanceolate to oblong, to 10 cm long, to 40 mm wide; *petioles* to 12 mm long. *Adult leaves* discolorous, hypostomatic, lanceolate, 7–12 cm long, 9–22 mm wide; *petioles* 8–16 mm long. *Peduncles* 5–12 mm long; *pedicels* 2–6 mm long. *Mature buds* 3–6 mm long, 2–4 mm diam. *Fruits* 6–10 mm long, 5–8 mm diam. Fig. 20.

Flowering: Not recorded.

Distinguished by the combination: adult leaves narrow (to 22 mm wide), amphistomatic, intermediate leaves narrow (less than 40 mm wide), buds small (less than 6 mm long).

This is the south-western subspecies, ranging from the Barakula district in Queensland south to Coonabarabran and near Denman in New South Wales (Fig. 19). Usually on skeletal soils on siliceous substrates, sometimes on deep sands.

Conservation status: Widespread and locally abundant, not considered to be at risk.

The epithet is from the Greek *amphi-*, both, and *stoma, stomatos*, a mouth, referring to the presence of stomates on both surfaces of the leaves.

Selected specimens (from 45 examined): Queensland: Chinchilla, *Beasley*, Feb 1914 (NSW); 12.5 [20 km] miles from Tara towards Chinchilla, *Brooker 4770*, 16 Apr 1975 (CANB, NSW); Inglewood, *White 6115*, Nov 1922 (BRI, NSW).

New South Wales: North Western Slopes: Salt Caves lookout tower, Denbollie State Forest, *K. Wilson 2466*, 18 Aug 1979 (NSW); c. 15 miles [25 km] from Coonabarabran on Gunnedah road, *Johnson*, 7 Nov 1951 (NSW 17916). North Western Plains: Woods Bend, Bebo State Forest, *Coveny 11711 & P. Wilson*, 2 Nov 1983 (NSW); Narrabri E, *Boorman s.n.*, Aug 1901 (NSW 302046). Central Western Slopes: Coxs Gap, 4 miles [6 km] W of Kerrabee, *Johnson*, 19 Sep 1951 (NSW 17943).

2C. ACETTAV **Corymbia trachyphloia** *(F. Muell.) K.D. Hill & L.A.S. Johnson* subsp. **carnarvonica** K.D. Hill & L.A.S. Johnson, **subsp. nov.**

Inter subspecies *C. trachyphloiae* combinatione characterum distinguitur: folia intermedia falcatim et late lanceolata; folia adulta amphistomatica late lanceolata (saepissime plus quam 25 mm lata), petiolis crassiusculis; alabastra magna (plus quam 5 mm longa).

Type: Queensland: Carnarvon Development Road, 4.3 km NNE of 3rd crossing of Dawson River, *P.H. Weston 1560 & P. Richards*, 14 Jan 1990 (holo NSW; iso BRI).

Juvenile leaves opposite, setose for about 15–20 nodes with bristle-glands and bearing simple hairs, narrow-lanceolate to oblong, mucronate, peltate after about node 5, to 10 cm long, to 30 mm wide; *petioles* to 6 mm long. *Intermediate leaves* disjunct, bristle-free, lanceolate to broad-lanceolate, falcate, to 20 cm long, to 60 mm wide; *petioles* to 30 mm long. *Adult leaves* disjunct, lanceolate to broad-lanceolate, ± discolorous but amphistomatic, acute or acuminate, 7–14 cm long, 14–40 mm wide; *petioles* 12–20 mm long. *Peduncles* 5–12 mm long; *pedicels* 2–7 mm long. *Mature buds* ovoid, 6–8 mm long, 3–5 mm diam. *Fruits* 8–10 mm long, 6–8 mm diam. Fig. 20.

Flowering: Jan.

Distinguished by the broad-lanceolate, falcate intermediate leaves, the consistently amphistomatic, broad-lanceolate adult leaves (frequently more than 25 mm wide), and the large buds (more than 5 mm long).

A localised subspecies occurring in the Blackdown Tableland and Carnarvon Range regions and on nearby sandstone outcrops in Central Queensland, on shallow soils on sandstone (Fig. 19). Some intergradation with subsp. *trachyphloia* occurs in marginal zones.

Conservation status: Although somewhat scattered in distribution, substantial populations exist in areas that are reasonably secure from disturbance, and this subspecies is not considered to be at risk.

The epithet refers to its presence in the Carnarvon Range and more or less neighbouring regions.

Selected specimens (from 12 examined): Queensland: Blackdown Tableland, northern slopes, *Gittins 940a*, Sep 1964 (NSW); 89 km S of Alpha towards Tambo, *Brooker 7870*, 8 Dec 1982 (CANB, NSW); Mt Moffatt National Park, sandstone ridge on road to Consuelo, *Bean 773*, 19 Feb 1988 (NSW); Boolimba Bluff, *Hill 1329*, 1 Jan 1986 (NSW); 22.9 km N of Mitchell-Roma road towards Forest Vale, *Blaxell 89/011, Johnson & D'Aubert*, 22 July 1989 (NSW, BRI, CANB, DNA).

ACI Section **Rufaria**

Rhizomes sometimes present. Bark persistent to partly or largely deciduous, shortly fibrous, parting in polygonal flakes; with enlarged phloem fibres. Juvenile leaves linear to ovate, sessile or petiolate, peltate or non-peltate, with or without simple hairs, with bristle-glands. Adult leaves hypostomatic or amphistomatic. Inflorescence terminal to infraterminal. Calyx calyptriform, persistent to anthesis. Petals ± free or corolla ± calyptriform, in both cases closely appressed and adherent to calycine calyptra. Style straight, tip not engaged in calyptra. Stigma shaggy with long papillae. Columella present in open fruits. Seeds winged or less often wingless, laterally compressed.

The sectional epithet is from the Latin *rufus*, red, referring to the frequent occurrence of reddish coloration in the bark and the vernacular name Red Bloodwoods. This is the extracodical epithet that we recommend for use in our system.

Major divisions in this section may be recognised on the morphology of seeds, and adult and juvenile leaves and perianth. Bark differences correlate in part with leaf morphology. We recognise 13 series, mostly tropical in distribution, though the series *Gummiferae* and *Ficifoliae* are wholly extratropical (Fig. 21).

Key to the series

It should be noted that this is an artificial key, and that it depends on juvenile (often seedling) characters and stomatiferous condition of leaves (± microscopic). Series placement of species is not easily determined in the absence of such characters.

1 Apparently adult leaves ± opposite, ± sessile .... Series **Ferrugineae** (ACIX)

1* Adult leaves disjunct

2 Seeds not terminally winged .... Series **Gummiferae** (ACIB)

2* Seeds terminally winged

3 Simple hairs present in juvenile state

4 Adult leaves weakly to strongly discolorous, hypostomatic or amphistomatic

5 Adult leaves dull; juvenile leaves subsessile or very shortly petiolate (less than 8 mm long) .... Series **Arenariae** (ACIQ)

5* Adult leaves highly glossy; juvenile leaves distinctly petiolate (more than 10 mm long) .... Series **Nesophilae** (ACID)

4* Adult leaves concolorous, amphistomatic

6 Juvenile leaves tightly cordate or peltate

7 Fruits brown-scaly; bark mostly persistent, not reddish .... Series **Cliftonianae** (ACIW)

7* Fruits not scaly; bark shedding extensively, with red scales .... Series **Collinae** (ACIS)

6* Juvenile leaves not tightly cordate or peltate .... Series **Porrectae** (ACIN)

3* Simple hairs absent (sometimes a very few in *Polycarpae*)

8 Juvenile leaves either tightly cordate or some of them peltate

9 Buds scurfy

10 Buds and fruits pedicellate .... Series **Ptychocarpae** (ACIJ)

10* Buds and fruits sessile .... Series **Abergianae** (ACIE)

9* Buds not scurfy .... Series **Intermediae** (ACIG)

8* Juvenile leaves not peltate, though sometimes cordate

11 Bark scales ± elongated; fruits very large .... Series **Ficifoliae** (ACIF)

11* Bark scales ± equidimensional; fruits small to medium

12 Bark brown, persistent throughout ..... Series **Polycarpae** (ACIL)

12* Bark orange-red, scaling off branches

13 Adult leaves hypostomatic, discolorous; intramarginal vein clearly separated from margin .... Series **Rhodopes** (ACIR)

13* Adult leaves amphistomatic, concolorous; intramarginal vein appearing confluent with margin (except in subseries *Oocarposae*) (see Fig. 7b) ...... Series **Dichromophloiae** (ACIV)

ACIB Series **Gummiferae**

Rhizomes not recorded. Seeds lacking a distinct terminal wing but laterally compressed. Bark mainly persistent but shedding on small branches to varying degrees. Early (but not earliest) juvenile leaves peltate, soon succeeded by bristle-free later juvenile leaves. Simple hairs absent, or if present usually so for 2 or 3 nodes only around the 4th node in seedlings, and often reduced and papilliform. Intramarginal vein close to margin or confluent with it on adaxial surface. Buds not scurfy. Petals free or almost so. Fruits not scurfy and with the lenticels not very conspicuous.

A series with an unusual distribution within the bloodwoods: one species in coastal temperate eastern Australia and three species in the wetter parts of south-western Western Australia (Fig. 21a). All species of the series occur on low-nutrient siliceous soils, and all have the capacity to form very large, many-stemmed clumps with broad plate-like lignotubers under extreme edaphic conditions. This capacity is viewed as an autapomorphy for this series, in which otherwise only characters taken to be plesiomorphic or homoplastic have been clearly defined, although the species display similarity in aspects of bark, leaf details and fruits. The almost complete suppression of simple hairs can be regarded as another apomorphy.

The distribution is evidently relictual, and may be compared with the relict disjunction of series *Ficifoliae* and eastern series (such as *Intermediae* (Figs. 21c, d). This implies a substantial evolutionary separation within the bloodwoods before the mid-Miocene climatic isolation of the south-east and south-west of Australia.

Two of the species, *C. haematoxylon* and *C. chlorolampra*, can be grouped as vicariant members of Superspecies *Haematoxylon*.

3. ACIBBA **Corymbia gummifera** *(Gaertner) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Metrosideros gummifera* Gaertner, Fruct. Sem. Pl. 1: 170, t. 34, fig. 1 (1788).

Type citation: 'Ex herbario Banksiano cum sequentibus.'

Type: the illustration of the fruiting organs only in Gaertner, Fruct. Sem. Pl. 1: t. 34, fig. 1 (1788). The author citation should be 'Gaertner' rather than 'Sol. ex Gaertner' as used by Chippendale (1988). Gaertner did not ascribe the name to Solander as the

Fig. 21. Distribution of series *Gummiferae* (a), series *Nesophilae* (b), series *Ficifoliae* (c), series *Intermediae* (d), series *Ptychocarpae* (e), series *Abergianae* (f), series *Polycarpae* (g), series *Porrectae* (h), series *Rhodopes* (i), series *Arenariae* (j), series *Collinae* (k), series *Dichromophloiae* (l), series *Cliftonianae* (m), series *Ferrugineae* (n).

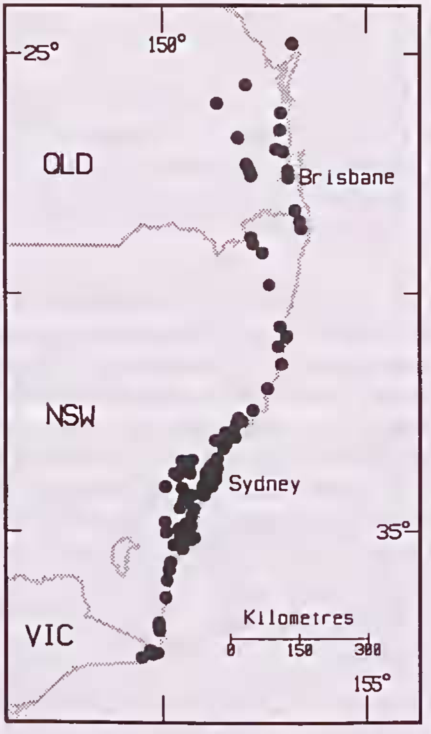

Fig. 22. Distribution of *C. gummifera*.

ICBN would require; he merely cited, in synonymy, '*Metrosideros gummifera, cortice rugoso*. Soland. mss'. This was one of two four-word phrase-names used by Solander for two quite different species, each one beginning with the same two words.

The illustration accompanying the protologue is taken as the holotype, since no matching specimens are known. A collection labelled 'J. Banks, Botany Bay'[1770] housed in BM is most likely to be from the same gathering as the specimen used by Gaertner, and can thus be taken as a probable isotype. Our concept of the species is in effect typified by this collection.

≡ *Eucalyptus gummifera* (Gaertner) Hochr., Candollea 2: 464 (1925). The combination was also published by Domin, Biblioth. Bot. 22 (89): 1022 (1928). In both cases, the author citation 'Sol. ex Gaertner' was applied, incorrectly.

= *E. corymbosa* Sm., Zool. Bot. New Holland: 43 (1793).

Type citation: None cited.

Type: New South Wales: Port Jackson, *J. White*, 1793 (holo LINN; iso BM, CGE, G, K).

= *E. oppositifolia* Desf., Tabl. Ecole Bot. ed. 1: 222 (1804).

Type citation: 'N. HOLL., or. h.'

Type: Ex Herb. Desfontaines (holo P). Figured by Maiden (Crit. Rev. Eucalyptus 4: plate 162, fig. 6, 1919).

This typification is discussed by Maiden (1904) and Blake (1953).

= *E. purpurascens* Link var. *petiolaris* DC., Prodr. 3: 221 (1828).

Type citation: None cited.

Type: Ex Jard. de Noisette, 11 July 1818 (holo G). Figured by Maiden (Crit. Rev. Eucalyptus 4, plate 162, fig. 5, 1919).

[*E. longifolia* Link ex Maiden, Crit. Rev. Eucalyptus 4: 265, 1919), pro syn., nom. invalid.; non Link & Otto, (1822), represents an unpublished herbarium name, later published in synonymy by Maiden. It refers to a drawing of a fruit in CGE, labelled '*E. longifolia* Lk., non Lindl. in Heward's Herbarium. Was gathered by A. Cunningham close under Blue Mountain, Warragamba.' This drawing is regarded as representing *E. corymbosa* by Maiden (Crit. Rev. Eucalyptus 4: 245, 1919).]

Tree to 35 m in favorable sites, often smaller and sometimes with many whipstick stems (though not a typical mallee) on poor sites. *Rhizomes* not recorded. *Bark* persistent except on small branches, deeply tessellated, grey-brown or red-brown, brown on freshly broken surfaces; smooth, peeling in thin scales on branches to 2–6 cm diam. *Cotyledons* 9 mm long, 14–15 mm wide; *petioles* 4–5 mm long. *Juvenile leaves* disjunct from about node 7, with a few short simple hairs in seedlings, setose with bristle-glands, but bristle-free from about node 7, ovate, peltate in seedlings but usually not so in coppice, 6–10 cm long, 25–40 mm wide; *petioles* 9–16 mm long. *Intermediate leaves* disjunct, bristle-free, similar to adult leaves, to 18 cm long, to 70 mm wide; *petioles* to 20 mm long. *Adult leaves* disjunct, strongly discolorous, glossy above, hypostomatic, lanceolate to broad-lanceolate, 10–14 cm long, 20–40 mm wide; *petioles* 10–23 mm long; *intramarginal vein* distinct; *oil glands* sparse and scattered. *Umbellasters* 7-flowered, *peduncles* 17–30 mm long; *pedicels* 9–14 mm long. *Mature buds* globular to broadly clavate, not scurfy, 8–11 mm long, 5–8 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, patelliform, sometimes minutely apiculate. *Fruits urceolate*, distinctly flared at the top, relatively thin-walled at rim, with scattered lenticel-like dots or scales, 15–20 mm long, 11–15 mm diam., 3- or 4-locular; *disc* 1–2 mm wide; style in pit. *Seeds* cymbiform, narrowly flanged on the dorsal keel, dull to semi-glossy, red-brown, 5–6 mm long, 1.5–2 mm wide.

Flowering: (Jan–)Feb–May.

Distinguished by the bark peeling on the small branches (of somewhat larger diameter than in related species), the red-brown (wingless) seeds and the relatively small fruits (within the subseries).

C. gummifera has often been confused with *C. intermedia*, which has rather similar leaves and fruits of similar size. The two are readily distinguished by fruit characters, *C. gummifera* fruits having a thin rim and relatively few and inconspicuous lenticel-like dots, as well as the shedding bark on small branches. *C. gummifera* also lacks the terminal wing on the seed present in *C. intermedia*.

Forms with strikingly large intermediate and, to a lesser extent, adult leaves occur in some localities, particularly in the north of the range (e.g. near Helidon, *Hill 3820*). Large-leaved individuals can, however, occur in many places through the range, and populations containing them do not appear to be sufficiently well defined to warrant taxonomic recognition.

Locally frequent to abundant from Fraser Island to far eastern Victoria (Fig. 22). This species usually occurs on sandy or other acid soils of low fertility, often on almost pure sand. Its habitat ranges from tall sclerophyll forest to open mallee heath, where the species often forms large many-stemmed clumps with a broad, plate-like lignotuber (Mullette 1978). *C. gummifera* can also form a large forest tree in wet forests on soils that are somewhat richer, but still usually very sandy. The distribution is mainly coastal, extending to the eastern ranges of the tablelands in southern Queensland and northern and central New South Wales. This species is strongly edaphically dependent, and, though abundant in some districts, its overall distribution is sporadic, particularly in the north of its range.

Hybrids with *C. maculata* (section *Politaria*) are known from southern coastal New South Wales, and were named *E. nowraensis* Maiden (see excluded names and Appendix 1). Reputed hybrids with *C. intermedia* have been reported (Clifford 1972) but we have seen no specimens or trees showing hybrid characters; these species have been confused by observers, though their differences are clear.

Conservation status: Widespread and locally abundant, this species is not considered to be at risk.

Selected specimens (from 186 examined): Queensland: Fraser Island, *Petrie NSW 10131, 10134*, July 1915, May 1915 (NSW); Mt Walsh, *Bean 7*, 17 Sep 1983 (NSW); 'Beeron' holding, 6 km WNW of 'Toondahra' homestead, *Bean 1113 & Forster*, 9 Sep 1989 (BRI, NSW); Crows Nest, *White*, Oct 1920 (BRI, NSW); 21.9 km N of Helidon on Ravensbourne road, *Hill 3820 & Stanberg*, 11 Aug 1990 (NSW, BRI, CANB); Chermside Hills, *Blake 21679*, 22 Feb 1962 (BRI, NSW).

New South Wales: North Coast: Minyon Falls, *Constable NSW 22210*, 16 Jan 1953 (NSW); 8.7 km from Gwydir Highway near Grafton on Dalmorton road, *Hill 4302, Johnson & Noble*, 3 Nov 1992 (NSW, BRI, CANB); South West Rocks, *Johnson 8439*, 28 Jan 1979 (NSW); 2 miles [3.2 km] W of Karuah, *Johnson*, 12 Oct 1953 (NSW 300255). Central Coast: Avoca Reserve, c. 5 km S of Grose Vale post office, *Hind 5629*, 2 July 1988 (NSW); Bulls Camp, between Linden and Woodford, *Coveny 4059 & Bisby*, 24 Mar 1972 (NSW); Ku-ring-gai Chase, *Mair & Constable*, 2 Nov 1950 (NSW 16400); 5.1 km N of Menai turnoff on Heathcote road, *Coveny 11162 & Thomas*, 14 July 1982 (NSW, CANB, K, L, MO, RSA); above Jamberoo Pass, *Pullen 4055*, 14 Apr 1964 (CANB, NSW). South Coast: 2.1 km E of Princes Highway on Jervis Bay road, *Chippendale 874 & Beeston*, 26 Feb 1974 (CANB, NSW); Jigamy Creek, 6 miles [9.6 km] N of Eden, *Constable*, 11 June 1960 (NSW 53821). Northern Tablelands: Boonoo Boonoo Falls, *Blaxell 1837*, 25 Mar 1981 (NSW); Timbarra, c. 15 miles [24 km] ENE of Tenterfield, *Constable*, 11 May 1961 (NSW). Central Tablelands: Hazelbrook, *Constable*, 14 Mar 1949 (NSW 15720); Box Point to Barbers Creek, *Maiden*, Oct 1898 (NSW).

Victoria: Barracouta Lake, E of Mallacoota Inlet, *Willis*, 6 Nov 1969 (MEL, NSW).

4. ACIBBE Corymbia haematoxylon *(Maiden) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus haematoxylon* Maiden, J. & Proc. Roy. Soc. New South Wales 47: 218 (1913).

Type citation: 'Habitat. Happy Valley, Jarrahwood Railway, Western Australia. Generally in poor sandy country. Forest Ranger W. Donovan, July, 1912.'

Type: Western Australia: Happy Valley, Jarrahwood Railway, *W. Donovan*, July 1912 (holo NSW).

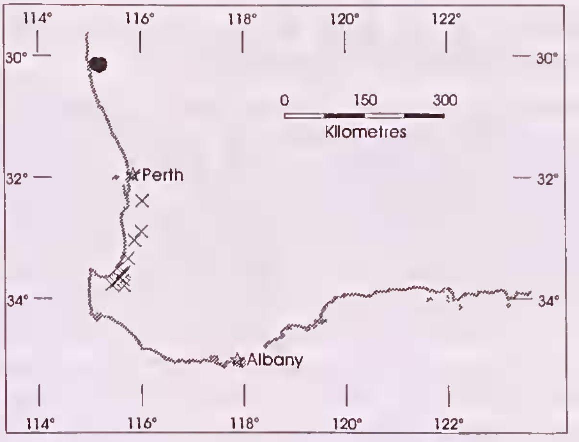

Fig. 23. Distribution of *C. haematoxylon* (cross), *C. chlorolampra* (circle).

Tree to 25 m. *Rhizomes* not recorded. *Bark* persistent except on fine branches <1–2 cm diam., finely fibrous, deeply tessellated, pale grey-brown to yellow-brown, yellow to bright orange on freshly broken surfaces. *Cotyledons* to 15 mm long, to 17 mm wide; *petioles* to 14 mm long. *Juvenile leaves* disjunct from about node 5, setose with bristle-glands, bristle-free from about node 8–10, ovate, peltate between about nodes 2 and 8, to 7 cm long, to 30 mm wide; *petioles* to 12 mm long. *Intermediate leaves* disjunct, bristle-free, slightly larger and broader than adult leaves, to 10 cm long, to 60 mm wide; *petioles* to 20 mm long. *Adult leaves* disjunct, discolorous, hypostomatic, dull, narrow-ovate to ovate, 7–12 cm long, 25–40 mm wide; *petioles* 10–24 mm long; *intramarginal vein* distinct, within 0.5 mm of leaf margin; *oil glands* small, regularly distributed. *Umbellasters* 7-flowered; *peduncles* 10–30 mm long; *pedicels* 10–18 mm long. *Mature buds* broadly clavate to pyriform, not scurfy, 7–10 mm long, 5–7 mm diam.; *calyptra* a small flattish disc comprising c. 1/8th of total bud length, narrower than hypanthium. *Fruits* ovoid-urceolate to globular, strongly apically constricted, 18–40 mm long, 12–20 mm diam.; 3-locular; *disc* c. 5 mm wide. *Seeds* cymbiform, with a narrow scarious flange on the dorsal keel, dull to semi-glossy, red-brown to brown, 8–12 mm long, 4–5 mm wide.

Flowering: Dec–Jan (also sporadically at other times in occasional trees).

Distinguished by the combination: bark persistent to smaller branches than in *C. gummifera*; adult leaves dorsiventral, somewhat dull; fruits large; seeds red-brown to brown with a distinct scarious flange.

Locally frequent, though the patches are sporadic, on and near the crest of the Darling Escarpment in south-western Western Australia, from near Keysbrook to east and slightly south-east of Busselton (Fig. 23). A component of forests of medium height on sandy soils over deep laterite or on massive laterite.

Hybrids with *C. calophylla* are said to occur, but we have seen no collections.

Conservation status: Although fairly localised, populations exist in managed forestry districts that are not considered to be under immediate threat.

Selected specimens (from 21 examined): Western Australia: Gobby road, near Keysbrook, *Brooker 8024*, 11 Mar 1983 (CANB, NSW, PERTH); Boyd River Road, 1.6 km E of South Coast Highway, *Hill 671 & Johnson*, 10 Nov 1983 (NSW); North Dardanup, *Steedman*, 28 Dec 1939 (NSW 26425); Williamson road, E of Busselton, *Brooker 9802*, 6 Nov 1987 (CANB, NSW, PERTH).

5. ACIBBL **Corymbia chlorolampra** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

C. haematoxylon affinis sed ab ea foliis adultis nitentibus, ovatis et valde acuminatis, differt.

Type: Western Australia: E foot of Mt Peron, (30°07'S, 115°08'E), M.I.H. Brooker 7994, 2 Mar 1983 (holo NSW; iso CANB, PERTH).

Small tree, several-stemmed, to 5 m. *Rhizomes* not recorded. *Bark* persistent to middle branches, finely fibrous, deeply tessellated, pale grey-brown to yellow-brown, yellow to bright orange on freshly broken surfaces. *Cotyledons* to 15 mm long, to 18 mm wide; *petioles* to 16 mm long. Juvenile leaves disjunct from asbout node 5, setose with bristle-glands, bristle-free from about node 8–10, ovate, peltate between about nodes 2 and 8, to 7 cm long, to 35 mm wide; petioles to 12 mm long. *Intermediate leaves* disjunct, bristle-free, slightly larger and broader than adult leaves, to 8 cm long, to 50 mm wide; petioles to 20 mm long. *Adult leaves* disjunct, discolorous, hypostomatic, glossy or semi-glossy, narrow-ovate to ovate, usually with a narrow, tapered 'drip-tip' (especially on shorter leaves), 4–10 cm long, 20–50 mm wide; *petioles* 9–26 mm long; intramarginal vein distinct, within 0.5 mm of leaf margin; *oil glands* small, regularly distributed. *Umbellasters* 7-flowered; *peduncles* 9–21 mm long;

Notes on the Development of the Fruit-bodies of Four Malayan Species of *Amanita* (Basidiomycetes)

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Abstract

The development of the fruit-bodies was observed under natural conditions in the forest. Those of *A. elata*, *A. princeps* and *A. virginea* took 12–14 days to reach maturity when they persisted for merely 1–3 days. Expanded fruit-bodies soon became fly-blown and this hastened their decay. *A. elata* and *A. princeps* fructify early in the fungus season, as do most Malayan species, but *A. virginea* appears towards the end of the season. The presence of these species is revealed only for a few days twice each year.

Introduction

These observations were made in 1929–1931. The species used to fructify in roughly the same places every year in the Singapore Botanic Gardens Jungle and at Bukit Timah Forest Reserve, as if they were mycorrhizal, though I could not associate them with particular trees. However, this fact enabled me to disturb the humus gently in the likely spots and discover the young primordia. When to look for them was a few days after heavy rain had soaked the ground after the drier months of January–February and July–August (Corner, 1935). These species were described by Corner and Bas (1962).

Amanita elata (Mass.) Corner et Bas

From 22 March and 22 September 1930 I watched the successful development of 6 fruit-bodies in the Singapore Botanic Gardens Jungle. They reached, eventually, overall heights of 70–95 mm with pilei 25–80 mm wide. Several other fruit-bodies which I began to measure rotted off before the stem emerged from the volva. Measurements were made at about 8 a.m. daily. On day 1, the unopened volva was 8–10 mm high, 4–5 mm wide. By day 3, it had grown to 16–25 mm high, 9–13 mm wide. At 8 a.m. on day 4, the volva had ruptured, evidently during the night, and the stem had begun to project the pileus; the overall height was 26–63 mm but the convex pileus was merely 14–20 mm wide; the volva had ruptured into flat pieces on the unopended and pale umber pileus. On day 5, four fruit-bodies A–D were fully expanded, 70–78 mm high with plane pilei 30–60 mm wide. Two fruit-bodies, E and F, were *c*. 80 mm high with half-open pilei 30–46 mm wide. On day 6, fruit-bodies A–D were the same but E and F had fully expanded, 80–95 mm high with plane pilei 36 and 80 mm wide respectively. On day 7, A–D were dead. On day 8, E and F had collapsed by 4 p.m.

Full expansion from the volva had taken 48–72 hours and seemed to occur mainly during the night. The plane pileus persisted sporing for some 50–60 hours. From the incidence of heavy rain at that time, I judged that the mycelium had taken *c*. 10 days to develop the primordia to their state on day 1. The full life of the fruit-body, therefore, would be 14–15 days with a sporing period of *c.* 2 days or 50–60 hours.

The largest fruit-bodies that I recorded for this species had stems 13 cm long and pilei 9 cm wide. Such fruit-bodies might require an extra day for development and enjoy another day of sporing.

Amanita sp. aff. **A. fritillaria** (Berk.) Sacc.

On 15 March 1931 I marked two young fruit-bodies of this species in the Singapore Botanic Gardens Jungle. They were expanding with overall height 30 mm and pilei 11 mm wide. They expanded fully overnight and next morning were 73 mm high with plane pilei 38 mm wide. They lasted, evidently sporing, in this state for *c.* 36 hours before collapsing.

Amanita princeps Corner et Bas

In March and September 1930, I watched the development of 18 specimens of this lofty species. It grew in the deep shade of Fern Valley in Bukit Timah Forest Reserve. My observations were made at 3–4 p.m. The youngest specimens found were enclosed in the volva 15–21 mm wide. In 2 days the volva had enlarged to 32–48 mm wide. The next day, which was day 4 in the sequence, the volva had ruptured, evidently at night, and the stem had reached its full height 15-25 cm but the pilei were only one quarter to half open with the intact veil still covering the gills. On day 5, the pileus was fully expanded, plane or concave, 10–19 cm wide. The fruit-bodies then persisted for some 36–48 hours before becoming rotten. Many flies and small beetles had crawled over the expanding pilei to lay their eggs, and larvae together with the heavy rain hastened the demise of the fruit-bodies. Early development up to the rupture of the volva probably took some 12 days. In my experience this conspicuous fungus could be seen merely on 3–4 days, twice a year in March and September.

Amanita virginea Mass.

This fungus is unlike other species of the genus in the Malay Peninsula because it fruits towards the end of the fungus season after 2–3 months of rainy weather. The fruit-bodies are not to be found in the usual run of fungus about March and September but in May or November–December. In 1929 I watched the development of 10 fruit-bodies which came up in the Singapore Botanic Gardens Jungle in the second half of November and in the first half of December. Four of these failed to grow beyond an early stage when the primordia were merely a few days old. The others conformed to the sequence shown in Table 1.

The primordia took 8–10 days to develop from 10–15 mm high to the fully expanded state. The sporing period from the rupture of the veil to the collapse of the fruit-body varied from 30–70 hours. The expanded fruit-bodies were soon swarmed over by little flies, and how long they would last clearly depended on the extent to which they were fly-blown.

In 3 fruit-bodies the veil began to rupture about noon but was not fully broken and detached until 4 hours later. In one case the veil ruptured during the night. The veil split irregularly and fell to the ground in fairly large pieces.

It seemed likely that the primordia 10–15 mm high were not more than 3–4 days old. All the primordia and the freshly expanded fruit-bodies had very firm, turgid and compact texture. On section, a pale amber fluid issued from the cut surface, especially of the pileus and stem-apex.

Table 1
Fruit-body development of *Amanita virginea*

Day 8 a.m.	Height overall mm	Pileus width mm	
1	10–15	9–10	pileus a small hump
2	20	14	
3	25	18	
4	38	23	
5	45	30–35	
6	60	40–45	
7	75–85	50–55	
8	90–100	75–85	veil rupture
9	105–140	135–145	
10	110–150	150–190	fully grown

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group this species with the above three. Seeds of *C. haematoxylon* are morphologically somewhat intermediate between those of *C. gummifera* and *C. calophylla*, with seeds of *C. chlorolampra* tending further towards the form of *C. calophylla*.

Abundant in forest and wetter woodland regions in south-western Western Australia, in all but the wettest areas, with an outlying northern population on the Greenough River (Fig. 25). Usually on sandy or lateritic, well-drained soils. A large forest tree in most areas, but forming well-developed several-stemmed clumps in heath country in refugia in drier regions such as the Stirling Range and the Mt Lesueur district. The formation of the mallee-like habit is also edaphically dependent, occurring only on very low-nutrient sands or sandy laterites. *C. calophylla* has a more rounded and umbrageous crown than the other species of the series, in particular *C. gummifera*. Peltation of juvenile leaves is also more evident in coppice shoots than it is in other members of the series.

Hybrids are known with *C. chlorolampra* and (especially in cultivation) with *C. ficifolia* (Appendix 1). They are also reputed to occur with *C. haematoxylon*.

Conservation status: Widespread and locally abundant, this species is not considered to be at risk.

Selected specimens (from 68 examined): Western Australia: Ellendale Pool, Greenough River, *Hill 2571 & Johnson*, 23 Nov 1986 (NSW, PERTH); Cockleshell Gully, E of Jurien on road to Green Head, *Pullen 9695*, 28 Nov 1974 (CANB, NSW); 2.9 [4.6 km] miles N of Bindoon, *Tindale 1266 a*, 27 Mar 1970 (NSW); 9.7 km E of Kelmscott on Brookton Highway, *Rodd 4808 & Fensom*, 6 Nov 1985 (NSW, PERTH); Boyagin Rock, *Hill 666, Johnson, Blaxell, Brooker & Hopper*, 8 Nov 1983 (NSW); 23.3 km ESE of Manjimup on Muirs Highway, *Johnson 9142 & B. Briggs*, 28 Oct 1988 (NSW); 4 km SE of Porongurup, *Crisp 5240*, 18 Jan 1979 (CBG, NSW, PERTH).

ACID Series **Nesophilae**

Rhizomes not recorded. Bark persistent except on smaller branches <c. 5 cm diam. Juvenile leaves ovate to orbicular, peltate, with simple hairs and bristle-glands, persistent for many nodes, with long and slender petioles. Adult leaves weakly to moderately discolorous but most often amphistomatic, glossy above; intramarginal vein clearly separated from margin. Corolla calyptriform, closely adherent to calyx. Seeds with a terminal wing, red-brown.

A unispecific series in high-rainfall regions of northern Australia, characterised by the persistent ovate peltate juvenile leaves, which retain simple hairs. Simple hairs occur at times on the bristle-glands as well as directly on the undersurface of the seedling and coppice leaves.

7. ACIDDN **Corymbia nesophila** *(Blakely) K.D. Hill & L.A.S Johnson*, **comb. nov.**

Basionym: *Eucalyptus nesophila* Blakely, Key Eucalypts: 90 (1934).

Type citation: '(G.F. Hill, No. 465), the type.'

Type: Northern Territory: Bathurst Island, *G.F. Hill 465* (holo NSW, 4 sheets). Figured by Maiden (Crit. Rev. Eucalyptus 5: plate 174, fig. 7, 1920), as *E. trachyphloia* F. Muell.

Tree to 30 m. *Rhizomes* not recorded. *Bark* persistent to branches c. 1-5 cm diam., shortly fibrous, tessellated, grey-brown, brown on freshly broken surfaces. *Cotyledons* not seen. *Juvenile leaves* disjunct from about node 5–10, setose with bristle-glands and bearing simple hairs, broad-lanceolate to ovate or orbicular, peltate or cordate, to 10 cm long, to 60 mm wide; *petioles* to 15 mm long. *Intermediate leaves* disjunct, bristle-free, lanceolate to ovate, somewhat larger than adult leaves, to 16 cm long, to 60 mm wide; *petioles* to 30 mm long. *Adult leaves* disjunct, somewhat discolorous, amphistomatic or less commonly hypostomatic, glossy, narrow-lanceolate to lanceolate, 8–18 cm long, 8–22 mm wide;

Notes on the Rare Fern, *Pteris holttumii* C. Chr.

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Abstract

Pteris holttumii C. Chr. was found in the vicinity of the lowland dipterocarp forest of Dent Peninsula, of Lahad Datu. It is the second record for Malaysia, and the only known record from the lowlands for the species.

Introduction

There is no comprehensive study on the Sabah ferns reported to date. The only detailed reference available is the work of Christensen and Holttum (1934) on the Mount Kinabalu ferns. The more recent treatments on the subject are rather general or restricted to specific taxa only (Price, 1987; Bidin & R. Jaman, 1989; Bidin, R. Jaman & K.M. Salleh, 1988). The richness of ferns in Sabah as exemplified by Mount Kinabalu, which habours about 500 species, will only be known once thorough studies have been conducted on the Crocker and Trus Madi Ranges as well as the lowlands.

In one of the many collecting trips to Sabah in search of ferns, the authors came across a handsome fern of the genus *Pteris* in the lowlands of the Tabin Wildlife Reserve of Dent Peninsula (near Lahad Datu, East Sabah, alt. 50 m). The fern, *Pteris holttumii* C. Chr. was found on a steep river bank near a waterfall. Extensive search in the area failed to find the species in other localities. Specimens collected are deposited at the Universiti Kebangsaan Malaysia Herbarium (UKMB) and a live plant brought back is grown in the Fernery of the same University (Fig. 1).

The find constitutes the second record for the species in Sabah. In describing the species in 1934, Christensen wrote: "This splendid new species, which I dedicate to its collector, is the finest novelty discovered in recent years. . . . " The species collected by R.E. Holttum near Dallas Mt. Kinabalu (alt. ±850 m) in 1931 was never recorded again in Sabah until the Tabin specimen surfaced. As for the region, the only finding for the species was by Hovenkamp & De Joncheere in Palu, Sulawesi at 500 m (Hovenkamp & De Joncheere, 1988).

Observations

External Features of *P. holttumii*

The gross morphological characters of the species resembles *Acrostichum aureum* in terms of size and divisions of frond. These characters prompted Christensen and Holttum to suggest that *Acrostichum* is derived from the Pterideae.

Rhizomes creep horizontally, slightly beneath ground, bearing solitary fronds at short intervals; thickly covered (especially at stipe base) by long wiry roots. Stipes are

Fig. 1. *Pteris holttumii* growing at the Universiti Kebangsaan Fernery.

grooved on the inner side, scattered, pale to yellowish, hard conicle prickles present. Fronds are simply pinnate; pinnae uniform, basal pinnae not branched on the basiscopic sides near the base, basiscopic side of the base fused to the rachis, each pinna about 40 cm long. Rachises and upperside of costae are grooved, lower costae prominent. Veins are reticulate, forming up to 10 series of aerioles. Sori are marginal, elongated, without inner indusium (Fig. 2 A–E).

Endomorphic Characteristics of the Stipe

In transectional view, the stipe is subsulcate in outline enclosing a single vascular bundle which runs throughout the stipe. The bundle is a modified U-shaped strand with a wide base.

Ogura (1972) stressed the importance of the shape of the xylem strand in segregating families and genera of ferns, including relationships among taxa. In *Pteris holttumii* the xylem strand follows the outline of the bundle with both ends curved inside but without hooks, which in Ogura's classification is termed as the non-hippocampus type (Fig. 2B).

Summary

Pteris holttumii was first collected in Sabah in 1931 and described in 1934. Extensive botanical surveys by later workers in other parts of Borneo (Iwatsuki *et al.* 1980; Iwatsuki & Kato, 1980*a*, & *b*, 1981 & 1983*a* & *b*) did not include the fern in their lists. With the present finding and that of Hovenkamp and De Joncheere in Sulawesi, it is established here that *P. holttumii* is found in the lowlands as well as at high elevations.

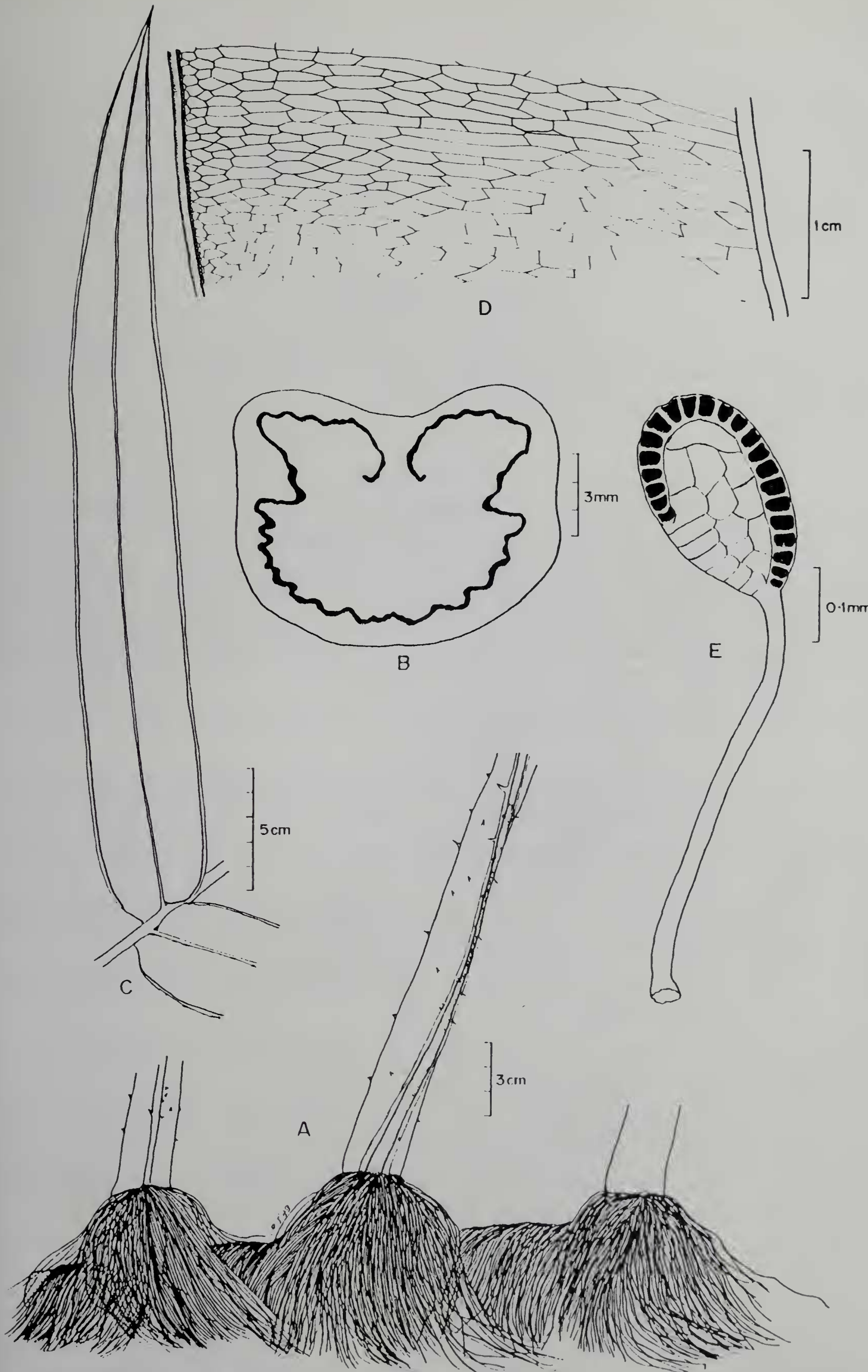

Fig. 2. *Pteris holttumii*. **A.** Part of rhizome, showing roots and stipe bases. **B.** Xylem configuration, middle of stipe. **C.** Part of frond, showing pinnae bases and sori outline. **D.** Vennation of pinna. **E.** Sporangium.

The species differs from the rest of the genus in having hard conicle prickles throughout the stipe as well as in the basal pinnae not being branched on the basiscopic sides near the base. It is the only species in *Pteris* with reticulate venation. It is hoped that with the availability of a live specimen in our collection, the cytology of the species would be determined in due time in order to give some indications on the phylogenetic relationship within the genus.

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A Botanical Survey of Pulau Ubin

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Abstract

An intense botanical survey of Pulau Ubin, a 1019.2 ha island within the Republic of Singapore, found at least 332 native and naturalized vascular plant species. These are listed in the paper together with 40 species found to have escaped from cultivation. Previous botanical records for Pulau Ubin are also collated. The contemporary flora is dominated by early successional and ruderal species in addition to mangrove and beach forest elements. The low diversity and relatively high frequency of aliens (71 out of 332 spp.; 21 per cent of the flora) reflects the high degree of human disturbance on the island.

Introduction

Pulau Ubin is an island within the Republic of Singapore. It was chosen as a site for an intensive botanical survey because as one of the least urbanised and under botanized areas of the city state it was believed likely to possess an interesting flora. Additionally, development of Pulau Ubin is currently a topic of public interest in Singapore. Basic biological information such as a plant species list is prerequisite to the development of nature conservation programmes. This survey will therefore be of value to those involved in future decisions concerning changes in land use on Pulau Ubin.

Site

Pulau Ubin (N 1° 25′, E 103° 57′) is a granite island of 1019.2 ha (Ng, 1988) lying off the north-east coast of Singapore Island (Fig. 1). The main land uses at present are granite quarrying, agriculture, horticulture, aquaculture and recreational activities, largely of an athletic nature. Pulau Ketam and P. Sekudu, islets to the south of Ubin, were also included in the survey.

Methods

Most of the specimens were gathered by a team of 19 collectors during the period 17–22 June 1990. Some collections have been made subsequently on occasional visits to the island up to May 1991. The collections have been identified, largely by matching to named specimens in the Herbarium, Singapore Botanic Gardens (SING). The Pulau Ubin specimens have been deposited in the Herbarium, Department of Botany, National University of Singapore (SINU).

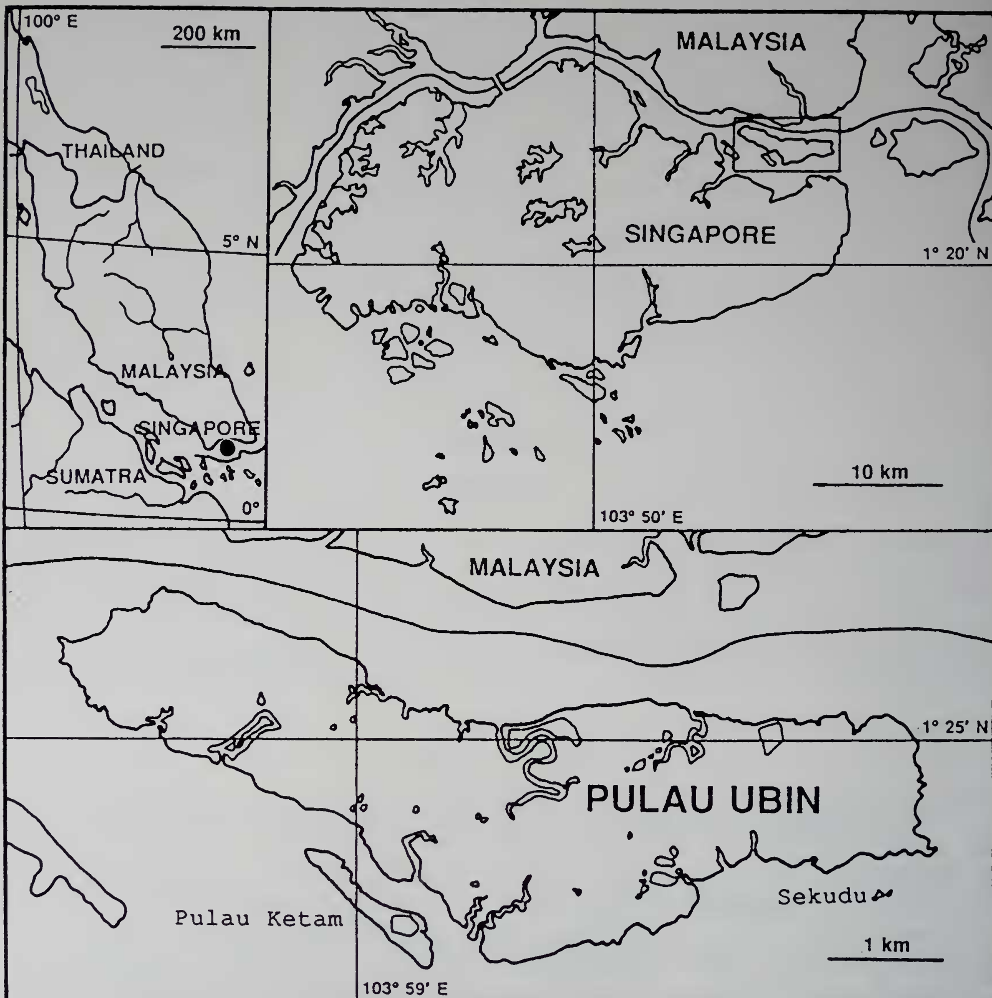

Fig. 1. Map showing locality of study site.

Results and Discussion

The names of the species collected are given in Table 1, the few sterile collections that could not be identified have been omitted. A total of 332 native and naturalized species were collected plus 40 species of cultivated plants that had escaped or were relics of cultivation in now abandoned areas. The distinction between alien and escaped species is somewhat arbitrary and is based largely on Turner, Chua and Tan (1990). The Ubin flora included 24 pteridophytes and one gymnosperm; the rest (including all the escapes) being angiosperms.

The Ubin flora represents about one eighth of the total flora recorded for Singapore. The species list is made up largely by common weed, secondary forest and mangrove species. Primary forest species are nearly completely lacking; a *Knema* species sapling being the only real rain forest tree found. The orchids *Spathoglottis plicata* and *Thrixspermum amplexicaule* were the most notable collections, though the former may possibly be a relic of cultivation. Eight species, *Adiantum latifolium, Hemigraphis primulaefolia, Pennisetum polystachyon, Scurrula parasitica, Sesamum radiatum,* *Talinum paniculatum, Thysanolaena latifolia* and *Typha angustifolia*, were not previously recorded for Singapore. All but *Scurrula parasitica* can be called weeds, being able to colonise disturbed sites readily.

Pulau Ubin was presumably covered in lowland rain forest and mature mangrove forest until at least the middle of the Nineteenth Century. A list of previous botanical records from the island (Table 2) does include some species one would associate more strongly with primary vegetation such as *Chisocheton macrophyllus, Cyathostemma viridiflorum, Dipterocarpus* c.f. *sublamellatus, Forrestia gracilis, Lithocarpus elegans, Phoebe grandis* and several celastraceous climbers, but the general impression is that even by the 1880s and 1890s when Ridley and Hullett were collecting on Pulau Ubin much of the vegetation must have been secondary. One has to conclude that all of the terrestrial vegetation has been cleared at some time, much of this by the turn of the century. The state of the mangrove is little better. There are earlier records for 156 species from Pulau Ubin, of which 111 were not re-collected in the survey. This clearly reflects the rapid changes that have occurred on the island.

Two late Nineteenth Century collections of Ridley from Pulau Ubin have been described as isosyntypes. Neither of these species, *Chisocheton macrophyllus* and *Ardisia singaporensis*, were re-collected and are thus very probably extinct in one of their type localities. Hullett's collection of *Claoxylon longifolium* from Ubin (Hullett s.n., March 1885) was described as a syntype of *Claoxylon longifolium* var. *brachystachys* by J.D. Hooker (Hooker 1887, p. 411) but this variety is now generally not recognized and the name reduced to synonymy with the type variety (e.g. Airy Shaw, 1972, Whitmore, 1973). Luerssen (1882) described *Phegopteris subdecurrens* from a fern collection made on Ubin (Kehding 2960) but this taxon is now generally synonymized to *Tectaria semipinnata* (Roxb.) Morton (e.g. Holttum, 1981).

The broad floristic changes brought about by human activities can be examined by comparing the relative abundances of the commonest angiosperm families in the current flora of Ubin and that recorded for Singapore as a whole (Table 3). The Orchidaceae are the commonest family in the flora of Singapore. Only five of the 194 species were found in the current survey on Pulau Ubin. The Leguminosae and the Euphorbiaceae are among the top three families with most species on contemporary Ubin. Both of these families have many weedy, alien species that have added to their diversity.

The flora of Pulau Ubin is clearly depauperate. Bukit Timah Nature Reserve has 854 species recorded (Corlett, 1990), nearly three times the number in one-fifteenth the area. Human interference on Pulau Ubin has lead to a semi-natural vegetation dominated by relatively few early successional species with a fairly high representation, 21 per cent of the flora, of alien species. It would be difficult to make a case for the conservation of the present day vegetation of Pulau Ubin on solely botanical grounds from an international perspective. However, from a Singapore standpoint, the patches of mangroves and the larger areas of belukar are of value in a country with so little natural vegetation remaining. Any plans for their destruction merit in-depth consideration of all the possible alternatives before being allowed to proceed.

Acknowledgements

The National University of Singapore Botany Honours Class (1990–1991) did most of the collecting on Pulau Ubin. We are most grateful for their efforts and enthusiasm. Our thanks also go to Soong Beng Ching, Shawn Lum and David Burslem for their assistance. We are grateful to the Director of the Singapore Botanic Gardens for allowing us access to the Herbarium. The survey was supported by the National University of Singapore.

Table 1

List of species collected on Pulau Ubin since June 1990. Representative collection given in square brackets. Marginal note: a = alien species naturalized in Singapore, e = escape from cultivation.

PTERIDOPHYTES

Acrostichum aureum L. [M.F. Choong 22]
Acrostichum speciosum Willd. [H.H. Neo 11]
a *Adiantum latifolium* Lamk. [M.Y. Kok 32]
Asplenium nidus L. [A. Ho & J. Lee 11]
Blechnum orientale L. [K.S. Tan 47]
Ceratopteris thalictroides (L.) Brongn. [K.S. Chua & H.T.W. Tan 427]
Davallia denticulata (Burm.) Mett. [A. Ho & J. Lee 13]
Dicranopteris linearis (Burm. f.) Underw. [A. Ho & J. Lee 1]
Drynaria quercifolia (L.) J. Sm. [A. Ho & E.M. Sim 21]
Lindsaea ensifolia Sw. [A. Ho & E.M. Sim 8]
Lycopodium cernuum L. [A. Ho & J. Lee 7]
Lygodium circinnatum (Burm. f.) Sw. [H.H. Neo 103]
Lygodium microphyllum Cav.) R. Br. [A. Ho & J. Lee 5]
Nephrolepis biserrata (Sw.) Schott [A. Ho & J. Lee 3]
Phymatosorus scolopendria (Burm.) Pichi Serm. [I.M. Turner 42]
a *Pityrogramma calomelanos* (L.) Link [M. Chan & Roslina 31]
Platycerium coronarium (Koenig) Desv. [T.S. Teo 59]
Pteridium caudatum (L.) Maxon ssp. *yarrabense* (Domin) Parris [K.S. Tan 56]
Pteris vittata L. [H.H. Neo 203]
Pyrrosia longifolia (Burm.) Morton [Latifah 6]
Pyrrosia piloselloides (L.) Price [A. Ho & J. Lee 12]
Schizaea digitata (L.) Sw. [H.H. Neo 206]
Stenochlaena palustris (Burm.) Bedd. [E.M. Sim & L.P. Ng 32]
Taenitis blechnoides (Willd.) Sw. [H.H. Neo 5]

SPERMATOPHYTES

Acanthaceae

Acanthus ebracteatus Vahl [E.M. Sim & L.P. Ng 18]
Acanthus volubilis Wall. [H.H. Neo 117]
a *Andrographis paniculata* (Burm. f.) Nees [J. Lee 104]
Asystasia nemorum Nees [E.M. Sim & L.P. Ng 14]
a *Hemigraphis primulaefolia* (Nees) Vill. [E.M. Sim & L.P. Ng 39]
a *Thunbergia fragrans* Roxb. [M. Chan & Roslina 32]
a *Thunbergia grandiflora* Roxb. [T.S. Teo 124]

Agavaceae

e *Sansevieria trifasciata* Prain [L.P. Ng 21]

Aizoaceae

Sesuvium portulacastrum L. [L.P. Law 4]

	Amaranthaceae
a	*Celosia argentea* L. [K.S. Tan 37]
	Cyathula prostrata (L.) Bl. [K.S. Chua 101]
e	*Gomphrena globosa* L. [J. Sim 31]
	Anacardiaceae
a	*Anacardium occidentale* L. [K.S. Chua & H.T.W. Tan 440]
	Bouea macrophylla Griff. [M.F. Choong 58]
	Buchanania arborescens (Bl.) Bl. [T.S. Teo 25]
	Campnosperma auriculatum (Bl.) Hook. f. [I.M. Turner 20]
e	*Mangifera indica* L. [J. Sim 33]
	Annonaceae
	Desmos dasymaschala (Bl.) Safford [M.F. Choong 38]
	Apocynaceae
e	*Allamanda cathartica* L. [J. Sim 40]
	Alstonia angustiloba Miq. [H.H. Neo 205]
a	*Catharanthus roseus* (L.) G. Don [A. Ho & E.M. Sim 7]
	Cerbera odollam Gaertn. [I.M. Turner 111]
	Araceae
a	*Alocasia macrorrhizos* (L.) G. Don [M.F. Choong 42]
a	*Colocasia esculenta* (L.) Schott [H.H. Neo 10]
e	*Dieffenbachia seguine* (Jacq.) Schott [T.S. Teo 70]
	Araliaceae
	Arthrophyllum diversifolium Bl. [L.P. Law 10]
e	*Polyscias fruticosa* (L.) Harms [T.S. Teo 60]
	Schefflera elliptica (Bl.) Harms [H.H. Neo 111]
	Asclepiadaceae
	Dischidia major (Vahl) Merr. [M.Y. Kok 36]
	Dischidia nummularia R. Br. [J. Lee 1]
	Hoya parasitica (Roxb.) Wall. ex. Wight [Latifah 117]
	Avicenniaceae
	Avicennia alba Bl. [J. Sim 23]
	Avicennia officinalis Bl. [T.S. Teo 16]
	Avicennia rumphiana Hall. f. [T.S. Teo 20]
	Bignoniaceae
a	*Spathodea campanulata* Beauv. [M.Y. Kok 27]
	Bombacaceae
e	*Durio zibethinus* J. Murray [K.S. Tan 17]
	Boraginaceae
a	*Cordia cylindristachya* R. & S. [E.M. Sim & L.P. Ng 43]
	Heliotropium indicum L. [Roslina 45]

	Bromeliaceae
e	*Ananas comosus* (L.) Merr. cv. Mauritius [J. Sim 27]
	Cannaceae
e	*Canna indica* L. [M. Chan 30]
	Capparaceae
a	*Cleome rutidosperma* DC. [Roslina 37]
	Caricaceae
e	*Carica papaya* L. [J. Sim 21]
	Casuarinaceae
	Casuarina equisetifolia J. R. & G. Forst. [J. Sim 7]
	Combretaceae
	Lumnitzera littorea (Jack) Voigt [M.Y. Kok 38]
	Lumnitzera racemosa Willd. [J. Sim 26]
	Terminalia catappa L. [J. Sim 1]
	Commelinaceae
	Commelina diffusa Burm. f. [L.P. Law 18]
	Compositae
a	*Ageratum conyzoides* L. [L.P. Ng & L.P. Law 2]
a	*Bidens pilosa* L. [K.S. Chua 100]
	Blumea balsamifera (L.) DC. [K.S. Chua & H.T.W. Tan 443]
	Eclipta prostrata (L.) L. [M.F. Choong 43]
	Elephantopus scaber L. [A. Ho & E.M. Sim 14]
	Emilia sonchifolia (L.) DC. ex Wight [A. Ho & E.M. Sim 15]
	Erigeron sumatrensis Retz. [M.Y. Kok 25]
	Gynura procumbens (Lour.) Merr. [L.P. Ng 8]
	Mikania cordata (Burm. f.) B.L. Robinson [M.Y. Kok 21]
	Pluchea indica (L.) Less. [Roslina 19]
a	*Sparganophora sparganophorus* (L.) C. Jeffrey [K.S. Chua & H.T.W. Tan 428]
	Spilanthes iabadicensis A.H. Moore [K.S. Chua & H.T.W. Tan 100]
a	*Synedrella nodiflora* (L.) Gaertn. [J. Lee 3]
	Tridax procumbens L. [M. Chan 33]
	Vernonia cinerea (L.) Less. [M.Y. Kok 33]
	Wedelia biflora (L.) DC. [M.Y. Kok 11]
a	*Wedelia trilobata* (L.) Hitch. [E.M. Sim & L.P. Ng 42]
	Youngia japonica (L.) DC. [T.S. Teo 125]
	Connaraceae
e	*Cnestis palala* (Lour.) Merr. [T.S. Teo 57]
	Convolvulaceae
	Erycibe tomentosa Bl. [T.S. Teo 54]
	Ipomoea aquatica Forsk. [A. Ho & E.M. Sim 34]
e	*Ipomoea batatus* (L.) Lamk. [L.P. Law & L.P. Ng 20]
a	*Ipomoea cairica* (L.) Sweet [J. Sim 41]
	Merremia tridentata (L.) Hallier f. [M. Chan 53]

Cucurbitaceae

e *Cucumis sativa* L. [M.F. Choong 50]

Cyperaceae

Bulbostylis barbata (Rottb.) Clarke [Roslina 21]

a *Cyperus aromaticus* (Ridl.) Mattf. & Kuk [Roslina 6]
Cyperus compactus Retz. [Latifah & H.H. Neo 2]
Cyperus compressus L. [Roslina 1]
Cyperus cyperinus (Retz.) Valck. Sur. [Latifah 2]
Cyperus halpan L. [M. Chan 13]
Cyperus javanicus Houtt. [A. Ho & E.M. Sim 66]
Cyperus kyllingia Endl. [Latifah 18]
Cyperus pilosus Vahl [Latifah & H.H. Neo 3]
Cyperus trialatus (Boeck.) Kern [Latifah 1]

Fimbristylis cymosa R. Br. [Latifah 12]
Fimbristylis dichotoma (L.) Vahl [Roslina 4]
Fimbristylis griffithii Boeck. [M. Chan 10]
Fimbristylis polytrichoides (Retz.) R. Br. [Latifah 11]
Fimbristylis schoenoides (Retz.) Vahl [H.H. Neo 204]

Hypolytrum nemorum (Vahl) Spreng. [H.H. Neo & Latifah 1]

Scleria corymbosa Roxb. [M. Chan & Roslina 27]
Scleria levis Retz. [Latifah 10]

Thoracostachyum bancanum (Miq.) Kurz [Latifah 13]

Dilleniaceae

Dillenia suffruticosa (Griff.) Mart. [E.M. Sim & L.P. Ng 8]

Tetracera indica (Christm. & Panz.) Merr. [E.M. Sim & L.P. Ng 27]

Dioscoreaceae

Dioscorea glabra Roxb. [T.S. Teo 29]
Dioscorea laurifolia Wall. ex Hook. f. [K.S. Chua & H.T.W. Tan 437]

Elaeocarpaceae

Elaeocarpus ferrugineus (Jack) Steud. [I.M. Turner 38]
Elaeocarpus pedunculatus Wall. ex Mast. [J. Sim 5]

a *Muntingia calabura* L. [T.S. Teo 43]

Eriocaulaceae

Eriocaulon longifolium Nees [M. Chan 12]

Erythroxylaceae

Erythroxylum cuneatum (Miq.) Kurz [K.S. Tan 30]

Euphorbiaceae

Antidesma velutinosum Bl. [L.P. Law 8]

e *Baccaurea motleyana* (M.A.) M.A. [A. Ho & E.M. Sim 13]

Breynia coronata Hook. f. [T.S. Teo 10]

Bridelia stipularis (L.) Bl. [M. Chan & Roslina 29]

Claoxylon indicum (Reinw. ex Bl.) Endl. ex Hassk. [M.F. Choong 19]

e *Codiaeum variegatum* (L.) Bl. [T.S. Teo 64]

	Croton hirtus L'Héritier [K.S. Tan 28]
a	*Euphorbia hirta* L. [M.F. Choong 40]
	Excoecaria agallocha L. [K.S. Tan 3]
	Glochidion superbum Baill. [I.M. Turner 113]
a	*Hevea brasiliensis* (Willd. ex A. Juss.) M.A. [M.Y. Kok 7]
	Macaranga conifera M.A. [M.Y. Kok 54]
	Macaranga gigantea (Rchb. f. & Zoll.) M.A. [L.P. Law & L.P. Ng 25]
	Macaranga griffithiana M.A. [I.M. Turner 116]
	Macaranga heynei I.M. Johnston [K.S. Tan 19]
	Macaranga hypoleuca (Rchb. f. & Zoll.) M.A. [M.Y. Kok 26]
	Macaranga triloba (Bl.) M.A. [L.P. Law & L.P. Ng 7]
	Mallotus paniculatus (Lamk.) M.A. [M. Chan & Roslina 25]
a	*Manihot esculenta* Crantz [M.Y. Kok 28]
a	*Manihot glaziovii* M.A. [H.H. Neo 104]
e	*Phyllanthus acidus* (L.) Skeels [T.S. Teo 50]
a	*Phyllanthus amarus* Schum. & Thonn. [A. Ho & E.M. Sim 35]
a	*Phyllanthus debilis* Klein ex Willd. [E.M. Sim & L.P. Ng 7]
a	*Phyllanthus urinaria* L. [E.M. Sim & L.P. Ng 35]
a	*Ricinus communis* L. [K.S. Tan 48]
	Sapium discolor (Champ. ex Benth.) M.A. [T.S. Teo 9]
	Suregada multiflora (Juss.) Baill. [I.M. Turner 30]
	Flagellariaceae
	Flagellaria indica L. [M. Chan 11]
	Gnetaceae
	Gnetum macrostachyum Hook. [J. Sim 13]
	Goodeniaceae
	Scaevola sericea Vahl [M.Y. Kok 39]
	Gramineae
a	*Axonopus compressus* (Swartz) Beauv. [M. Chan 15]
e	*Bambusa glaucescens* (Willd.) Sieb. [T.S. Teo 28]
	Centotheca lappacea (L.) Desv. [Latifah 3]
a	*Chloris barbata* Swartz [A. Ho & E.M. Sim 27]
	Chrysopogon aciculatus (Retz.) Trin. [Latifah 15]
a	*Coix lacryma-jobi* L. [T.S. Teo 39]
	Cynodon dactylon (L.) Pers. [K.S. Chua & H.T.W. Tan 447]
	Cyrtococcum accrescens (Trin.) Stapf [Latifah & H.H. Neo 5]
	Dactyloctenium aegyptium (L.) P. Beauv. [Roslina 17]
	Digitaria ciliaris (Retz.) Koel. [K.S. Chua & H.T.W. Tan 446]
	Echinochloa colona (L.) Link [M. Chan & Roslina 34]
	Eleusine indica (L.) Gaertn. [M. Chan 18]
	Eragrostis pilosa (L.) P. Beauv. [Latifah 9]
	Imperata cylindrica (L.) P. Beauv. [M. Chan 8]

Table 1 *(Continued)*

	Ischaemum indicum (Houtt.) Merr. [Roslina 3]
	Ischaemum muticum L. [M. Chan 1]
	Mnesithea glandulosa (Trin.) Koning & Sosef [T.S. Teo 121]
a	*Panicum maximum* Jacq. [L.P. Law 23]
a	*Paspalum conjugatum* Berg. [Latifah 6]
	Paspalum orbiculare Forst. f. [Latifah 7]
a	*Pennisetum polystachyon* (L.) Schult. [Roslina 16]
	Pogonatherum paniceum (Lamk.) Hack. [K.S. Chua & H.T.W Tan 445]
a	*Rhynchelytrum repens* (Willd.) C.E. Hubb. [Roslina 7]
	Saccharum arundinaceum Retz. [L.P. Law 17]
	Sporobolus indicus (L.) R. Br. [M. Chan 12]
a	*Thysanolaena latifolia* (Roxb. ex Hornem.) Honda [A. Ho & E.M. Sim 19]
	Zoysia matrella (L.) Merr. [M. Chan 14]
	Guttifera
	Calophyllum inophyllum L. [M.Y. Kok 51]
	Calophyllum pulcherrimum Wall. ex Choisy [H.H. Neo 207]
e	*Garcinia mangostana* L. [K.S. Tan 15]
	Garcinia nigrolineata Planch. ex T. Anders. [E.M. Sim & L.P. Ng 51]
	Hypoxidaceae
	Curculigo orchioides Gaertn. [K.S. Tan 27]
	Ixonanthaceae
	Ixonanthes reticulata Jack [M.F. Choong 17]
	Labiatae
a	*Hyptis brevipes* Poit. [A. Ho & E.M. Sim 20]
a	*Hyptis capitata* Jacq. [K.S. Chua 99]
a	*Hyptis suaveolens* (L.) Poit. [A. Ho & E.M. Sim 45]
	Leucas zeylanica (L.) R. Br. [E.M. Sim & L.P. Ng 36]
	Ocimum basilicum L. [A. Ho & E.M. Sim 33]
	Lauraceae
	Cassytha filiformis L. [L.P. Law 21]
	Cinnamomum iners Reinw. ex Bl. [K.S. Tan 49]
	Neolitsea zeylanica Merr. [M.Y. Kok 29]
	Leeaceae
	Leea indica (Burm. f.) Merr. [M.Y. Kok 31]
	Leguminosae
a	*Abrus precatorius* L. [J. Lee 4]
a	*Acacia auriculiformis* A. Cunn. ex Benth. [J. Sim 15]
e	*Acacia mangium* Willd. [I.M. Turner 44]
	Alysicarpus vaginalis (L.) DC. [E.M. Sim & L.P. Ng 48]
e	*Andira inermis* (W. Wright) H.B.K. ex DC. [I.M. Turner 115]
	Archidendron clypearia (Jack) I. Nielsen [M.F. Choong 16]

	Caesalpinia crista L. [K.S. Chua & H.T.W. Tan 426]
	Calopogonium mucunoides Desv. [L.P. Ng 10]
	Canavalia cathartica Thou. [A. Ho & J. Lee 15]
a	*Cassia alata* L. [L.P. Law 19]
a	*Cassia lechenaultiana* DC. [K.S. Chua 80]
a	*Cassia mimosoides* L. [L.P. Ng & L.P. Law 19]
	Centrosema pubescens Benth. [A. Ho & E.M. Sim 44]
a	*Clitoria laurifolia* Poir. [J. Sim 18]
	Crotalaria mucronata Desv. [K.S. Tan 8]
	Dalbergia candenatensis (Dennst.) Prain [T.S. Teo 17]
e	*Derris elliptica* (Roxb.) Benth. [M.Y. Kok 3]
	Derris trifoliata Lour. [A. Ho & J. Lee 14]
	Desmodium heterocarpon (L.) DC. [L.P. Ng & L.P. Law 14]
	Desmodium heterophyllum (Willd.) DC. [M. Chan & Roslina 31]
	Desmodium umbellatum (L.) DC. [M.F. Choong 11]
	Entada spiralis Ridl. [K.S. Tan 12]
	Intsia bijuga (Colebr.) O. Ktze. [K.S Chua & H.T.W. Tan 441]
a	*Mimosa invisa* Mart. ex Colla [T.S. Teo 42]
a	*Mimosa pigra* L. [M.F. Choong 28]
a	*Mimosa pudica* L. [M. Chan & Roslina 30]
a	*Neptunia plena* (L.) Benth. [T.S. Teo 71]
	Peltophorum pterocarpum (DC.) Backer ex Heyne [K.S. Tan 25]
e	*Pterocarpus indicus* Willd. [A. Ho & E.M. Sim 40]
	Lemnaceae
	Lemna perpusilla Torrey [K.S. Chua & H.T.W. Tan 449]
	Liliaceae
e	*Cordyline fruticosa* (L.) A. Chev. [L.P. Law 15]
	Dianella ensifolia (L.) DC. [M. Chan 19]
e	*Gloriosa superba* L. [J. Lee 102]
	Linaceae
	Indorouchera griffithiana (Planch.) Hallier f. [H.H. Neo 208]
	Loganiaceae
	Fagraea acuminatissima Merr. [I.M. Turner 105]
	Fagraea fragrans Roxb. [M.Y. Kok 12]
	Loranthaceae
	Dendrophthoe pentandra (L.) Miq. [A. Ho & J. Lee 10]
	Macrosolen cochinchinensis (Lour.) Tiegh. [H.H. Neo 114]
	Scurrula parasitica L. [P.T. Chew & A.S. Chew 46]
	Magnoliaceae
e	*Michelia champaca* L. [J. Lee 5]
	Malpighiaceae
	Tristellateia australasiae A. Rich. [E.M. Sim & L.P. Ng 20]

Table 1 *(Continued)*

	Malvaceae
e	*Hibiscus rosa-sinensis* L. [L.P. Ng 14]
	Hibiscus tiliaceus L. [E.M. Sim & L.P. Ng 4]
	Sida rhombifolia L. [E.M. Sim & L.P. Ng 41]
	Thespesia populnea (L.) Soland. ex Correa [J. Lee 8]
	Urena lobata L. [E.M. Sim & L.P. Ng 34]
	Melastomataceae
a	*Clidemia hirta* D. Don [E.M. Sim & L.P. Ng 6]
	Dissochaeta gracilis (Jack) Bl. [K.S. Chua 104]
	Melastoma malabathricum L. [E.M. Sim & L.P. Ng 2]
	Memecylon edule Roxb. [K.S. Tan 20]
	Meliaceae
	Xylocarpus granatum Koen. [M.F. Choong 4]
	Menispermaceae
	Fibraurea tinctoria Lour. [L.P. Ng & L.P. Law 4]
	Limacia scandens Lour. [M.F. Choong 20]
	Moraceae
e	*Artocarpus integer* (Thunb.) Merr. [J. Lee 6]
e	*Artocarpus heterophyllus* Lamk. [A. Ho & E.M. Sim 26]
	Ficus aurata Miq. [K.S. Tan 63]
	Ficus fistulosa Reinw. ex Bl. [M.F. Choong 49]
	Ficus grossularioides Burm. f. [M.F. Choong 6]
	Ficus heteropleura Bl. [M.Y. Kok 19]
	Ficus microcarpa L. f. [T.S. Teo 34]
	Ficus variegata Bl. [K.S. Tan 36]
	Ficus virens Ait. var. *glabella* (Bl.) Corner [M.F. Choong 36]
	Streblus elongatus (Miq.) Corner [M.Y. Kok 47]
	Musaceae
e	*Musa acuminata* Colla cultivar [J. Sim 32]
	Myricaceae
	Myrica esculenta Buch.-Ham. [L.P. Law & L.P. Ng 8]
	Myristicaceae
	Knema sp. [K.S. Tan 51]
	Myrsinaceae
	Ardisia crenata Sims [T.S. Teo 72]
	Ardisia elliptica Thunb. [T.S. Teo 14]
	Embelia ribes Burm. [M.Y. Kok 16]
	Myrtaceae
e	*Eugenia jambos* L. [K.S. Tan 54]
	Eugenia longiflora (Presl) F.-Vill. [M.Y. Kok 14]
	Eugenia palembanica (Miq.) Merr. [K.S. Tan 18]
	Eugenia spicata Lamk. [T.S. Teo 1]

e	*Psidium guajava* L. [M.Y. Kok 30]
	Rhodamnia cinerea Jack [J. Sim 19]
	Rhodomyrtus tomentosa (Ait.) Hassk. [Roslina 15]
	Tristaniopsis whitiana (Griff.) Wilson & Waterhouse [M.Y. Kok 40]
	Nepenthaceae
	Nepenthes gracilis Korth. [E.M. Sim & L.P. Ng 54]
	Olacaceae
	Ximenia americana L. [K.S. Tan 1]
	Onagraceae
	Ludwigia hyssopifolia (G. Don) Exell [M. Chan & Roslina 30]
	Opiliaceae
	Champereia manillana (Bl.) Merr. [E.M. Sim & L.P. Ng 13]
	Orchidaceae
	Bromheadia finlaysoniana (Lindl.) Rchb. f. [M. Chan 61]
	Dendrobium crumenatum Sw. [A. Ho & J. Lee 9]
	Spathoglottis plicata Bl. [A. Ho & E.M. Sim 42]
	Thrixspermum amplexicaule (Bl.) Rchb. f. [T.S. Teo 32]
	Vanilla griffithii Rchb. f. [T.S. Teo 26]
	Oxalidaceae
a	*Oxalis barrelieri* L. [E.M. Sim & L.P. Ng 9]
a	*Oxalis corniculata* L. [J. Lee 2]
	Palmae
e	*Arenga pinnata* (Wurmb) Merr. [H.H. Neo 112]
	Caryota mitis Lour. [K.S. Tan 10]
a	*Cocos nucifera* L. [K.S. Tan 5]
	Licuala spinosa Wurmb [J. Sim 12]
	Nypa fruticans Wurmb [J. Sim 29]
	Oncosperma tigillarium (Jack) Ridl. [I.M. Turner 37]
	Pandanaceae
e	*Pandanus amaryllifolius* Roxb. [K.S. Tan 46]
	Pandanus odoratissimus L. f. [J. Sim 2]
	Pandanus yvanii Solms. [L.P. Law & L.P. Ng 3]
	Passifloraceae
a	*Passiflora foetida* L. [K.S. Tan 13]
a	*Passiflora laurifolia* L. [E.M. Sim & L.P. Ng 44]
a	*Passiflora suberosa* L. [A. Ho & J. Lee 45]
	Pedaliaceae
a	*Sesamum radiatum* Schum. [K.S. Chua & H.T.W. Tan 82]
	Piperaceae
a	*Peperomia pellucida* (L.) H.B.K. [M.F. Choong 39]

e	*Piper betle* L. [I.M. Turner 53]
	Piper sarmentosum Roxb. ex Hunter [M. Chan & Roslina 29]
	Plantaginaceae
a	*Plantago major* L. [M.F. Choong 52]
	Portulacaceae
a	*Talinum paniculatum* (Jacq.) Gaertn. [M.F. Choong 57]
	Rhamnaceae
	Colubrina asiatica L. ex Brongn. [T.S. Teo 38]
	Rhizophoraceae
	Bruguiera cylindrica (L.) Bl. [T.S. Teo 19]
	Bruguiera gymnorrhiza (L.) Lamk. [T.S. Teo 23]
	Ceriops tagal (Perr.) C.B. Robinson [M.F. Choong 29]
	Gynotroches axillaris Bl. [A. Ho & E.M. Sim 56]
	Rhizophora apiculata Bl. [M.F. Choong 31]
	Rhizophora mucronata Poir. [M.F. Choong 47]
	Rubiaceae
a	*Borreria alata* (Aubl.) DC. [M.F. Choong 15]
	Borreria articularis (L. f.) F.N. Will. [E.M. Sim & L.P. Ng 29]
	Borreria laevicaulis (Miq.) Ridl. [A. Ho & E.M. Sim 9]
	Borreria setidens (Miq.) Bold. [K.S. Chua & H.T.W. Tan 434]
a	*Diodia ocymifolia* (Willd. ex R. & S.) Bremek. [A. Ho & E.M. Sim 17]
	Guettarda speciosa L. [J. Sim 9]
	Hedyotis corymbosa (L.) Lamk. [L.P. Law & L.P. Ng 61]
	Ixora congesta Roxb. [T.S. Teo 24]
a	*Morinda citrifolia* L. [A. Ho & E.M. Sim 3]
	Morinda umbellata L. [E.M. Sim & L.P. Ng 47]
	Oxyceros longiflora (Lamk.) Yamazaki [E.M. Sim & L.P. Ng 31]
	Scyphiphora hydrophyllacea Gaertn. f. [T.S. Teo 15]
	Tarenna costata (Miq.) Merr. [T.S. Teo 4]
	Tarenna fragrans (Nees) K. & V. [T.S. Teo 3]
	Timonius wallichinus (Korth.) Valeton [J. Sim 2]
	Rutaceae
	Euodia roxburghiana (Cham.) Benth. ex Hook. f. [K.S. Chua & H.T.W. Tan 108]
e	*Murraya koenigii* (L.) Spreng. [M. Chan 27]
	Santalaceae
	Dendrotrophe varians (Bl.) Miq. [I.M. Turner 102]
	Sapindaceae
	Allophyllus cobbe (L.) Raeusch. [M.Y. Kok 22]
	Guioa pleuropteris (Bl.) Radlk. [A. Ho & E.M. Sim 57]
	Mischocarpus sundaicus Bl. [I.M. Turner 36]
e	*Nephelium lappaceum* L. [M.Y. Kok 45]

Sapotaceae

Planchonella obovata (R. Br.) Pierre [T.S. Teo 12]

Scrophulariaceae

a *Limnophila sessiliflora* Bl. [K.S. Chua & H.T.W. Tan 431]

Lindernia antipoda (L.) Alston [E.M. Sim & L.P. Ng 30]
Lindernia crustacea (L.) F.v.M. [K.S. Chua & H.T.W. Tan 432]
Lindernia sessiliflora (Benth.) Wettst. [K.S. Chua & H.T.W. Tan 433]

a *Scoparia dulcis* L. [A. Ho & E.M. Sim 18]

Simaroubaceae

Brucea javanica (L.) Merr. [T.S. Teo 45]

Smilacaceae

Smilax megacarpa DC. [K.S. Chua & H.T.W. Tan 425]

Solanaceae

Physalis minima L. [K.S. Chua 71]

e *Solanum melongena* L. [K.S. Chua 72]
a *Solanum torvum* Sw. [M.Y. Kok 17]

Sonneratiaceae

Sonneratia alba J.J. Smith [K.S. Chua & H.T.W. Tan 442]
Sonneratia ovata Backer [J. Lee 7]

Sterculiaceae

Commersonia bartramia (L.) Merr. [M.Y. Kok 52]

Heritiera littoralis Dryand. ex W. Ait. [I.M. Turner 45]

Pterospermum diversifolium Bl. [T.S. Teo 40]

Symplocaceae

Symplocos fasciculata Zoll. [E.M. Sim & L.P. Ng 52]

Theaceae

Adinandra dumosa Jack [E.M. Sim & L.P. Ng 26]

Eurya acuminata DC. [M.Y. Kok 56]

Thymelaeaceae

Linostoma pauciflorum Griff. [Latifah & H.H. Neo 4]

Tiliaceae

Triumfetta rhomboidea Jacq. [M.F. Choong 55]

Turneraceae

a *Turnera ulmifolia* L. [Roslina 12]

Typhaceae

a *Typha angustifolia* L. [I.M. Turner 117]

Ulmaceae

Trema cannabina Lour. [K.S. Tan 34]
Trema tomentosa (Roxb.) Hara [A. Ho & E.M. Sim 40]

Table 1 *(Continued)*

	Umbelliferae
	Centella asiatica (L.) Urb. [Roslina 28]
	Urticaceae
	Laportea interrupta (L.) Chew [H.H. Neo 105]
	Verbenaceae
	Clerodendrum inerme (L.) Gaertn. [E.M. Tim & L.P. Ng 49]
	Clerodendrum laevifolium Bl. [E.M. Sim & L.P. Ng 44]
e	*Clerodendrum paniculatum* L. [T.S. Teo 61]
e	*Clerodendrum philippinum* Schauer [A. Ho & E.M. Sim 22]
	Clerodendrum villosum Bl. [K.S. Chua 69]
	Gmelina asiatica L. [J. Lee 103]
a	*Lantana camara* L. [T.S. Teo 31]
	Premna corymbosa (Burm. f.) Rottl. & Willd. [K.S. Tan 35]
	Stachytarpheta indica (L.) Vahl [K.S. Chua 95]
	Vitex pinnata L. [J. Sim 14]
	Vitex trifolia L. [K.S. Tan 52]
	Vitaceae
	Ampelocissus elegans (Kurz) Gegnep. [M.Y. Kok 7]
	Cissus hastata (Miq.) Planch. [A. Ho & E.M. Sim 6]
	Zingiberaceae
e	*Languas galanga* (L.) Stuntz. [L.P. Law 9]

Table 2
Species previously recorded from Pulau Ubin;
representative collections are indicated in square brackets.

Species	Reference
PTERIDOPHYTES	
Adiantum flabellulatum L.	Ridley 1900
Asplenium macrophyllum Sw.	Ridley 1900
Cheilanthes tenuifolia (Burm.) Sw.	Ridley 1900
Drynaria sparsisora (Desv.) Moore	Johnson 1977
Humata heterophylla (Sm.) Desv.	Johnson 1977
Lindsaea divergens Hk. & Grev.	Johnson 1977
Phymatosorus scolopendria (Burm.) Pic. Ser.	Johnson 1977
Pityrogramma calomelanos (L.) Link	Johnson 1977
Pteris ensiformis L. [Ridley 3040]	–
Pyrrosia lanceolata (L.) Farwell [Ridley 9510]	Ridley 1900
Tectaria semipinnata (Roxb.) Morton [Ridley 6027]	Johnson 1977

Table 2 *(Continued)*

Species	Reference
SPERMATOPHYTES	
Agavaceae	
Dracaena elliptica Thunb.	Ridley 1900
Dracaena porteri Bak.	Ridley 1900
Amaranthaceae	
Amaranthus lividus L. [Ridley 4690]	Keng 1990
Cyathula prostrata (L.) Bl.	Ridley 1900
Amaryllidaceae	
Crinum asiaticum L.	Ridley 1900
Annonaceae	
Cyathostemma viridiflorum Griff. [Ridley s.n. Feb 1894]	Keng 1990
Apocynaceae	
Urceola lucida (DC.) Hook. f. [Ridley s.n. 1894]	Ridley 1900
Urnularia flavescens (Hook. f.) Stapf	Ridley 1900
Willughbeia coriacea Wall. [Ridley 9501]	Ridley 1900
Willughbeia grandiflora Dyer ex Hook. f. [Ridley s.n. 1893]	Markgraf 1972
Araceae	
Aglaonema simplex Bl. [Ridley s.n. 1890]	Ridley 1900
Araliaceae	
Schefflera cephalotes (C.B. Clarke) Harms.	Ridley 1900
Schefflera lanceolata Ridl.	Ridley 1900
Asclepiadaceae	
Calotropis procera (Ait.) Ait. f. — esc. cult.	Ridley 1900
Avicenniaceae	
Avicennia officinalis Bl.	Ridley 1900
Bignoniaceae	
Dolichandrone spathacea (L. f.) K. Schum.	Ridley 1900
Celastraceae	
Reissantia indica (Willd.) Hallé	Ridley 1900
Salacia chinensis L.	Ridley 1900
Salacia grandiflora Kurz [Ridley 4784]	Ridley 1900
Commelinaceae	
Aclisia secundiflora (Bl.) Bakh. f. [Ridley 4759]	Ridley 1900
Forrestia gracilis Ridl. [Ridley 4810]	Ridley 1900
Compositae	
Adenostemma lavenia (L.) O. Kuntze [Hullett 78]	Ridley 1900
Blumea riparia (Bl.) DC. [Ridley s.n. 1894]	—

Table 2 *(Continued)*

Species	Reference
Eleuthanthera ruderalis (Sw.) Sch.-Bip. [Furtado 18629]	Ridley 1900
Erigeron sumatrensis Retz. [Furtado 18342]	Ridley 1923
Synedrella nodiflora (L.) Gaertn. [Furtado 18624]	–
Tridax procumbens L. [Furtado 18347]	–
Wedelia biflora (L.) DC. [Hullett 387]	Keng 1990
Connaraceae	
Connarus planchonius Schellenb.	Ridley 1900
Cyperaceae	
Fimbristylis ferruginea (L.) Vahl	Ridley 1900
Scleria oblata S.T. Blake [Furtado 18630]	Blake 1961
Dipterocarpaceae	
Dipterocarpus c.f. *sublamellatus* Foxw. [Ridley s.n. 1890]	–
Euphorbiaceae	
Acalypha indica L.	Keng 1990
Antidesma velutinosum Bl. [Hullett 629]	Ridley 1900
Claoxylon longifolium Endl. ex Hassk. [Hullett s.n. 1885]	Ridley 1900
Galearia fulva (Tul.) Miq.	Ridley 1900
Glochidion microbotrys Hook. f.	Ridley 1900
Macaranga triloba (Bl.) M.A.	Ridley 1900
Suregada multiflora (Juss.) Baill.	Ridley 1900
Fagaceae	
Lithocarpus elegans (Bl.) Hatus. ex Soepadmo	Ridley 1900
Lithocarpus wallichianus (Lindl. ex Hance) Rehd. [Ridley 7479]	Soepadmo 1970
Flagellariaceae	
Flagellaria indica L.	Ridley 1900
Goodeniaceae	
Scaevola sericea Vahl	Ridley 1900
Gramineae	
Chloris barbata Sw. [Furtado 18348]	–
Digitaria ciliaris (Retz.) Koel. [Furtado 18637]	–
Digitaria violascens Link [Ridley s.n. 1894]	–
Eragrostis tenella (L.) P. Beauv. ex R. & S. [Ridley s.n. 1892]	–
Ischaemum muticum L. [Furtado 18625]	–
Leptaspis urceolata (Roxb.) R. Br. [Ridley 369]	–
Mnesithea glandulosa (Trin.) Koning & Sosef [Ridley s.n. 1892]	Ridley 1900
Guttiferae	
Calophyllum inophyllum L.	Ridley 1900
Garcinia eugeniaefolia Wall. ex T. Anders. [Ridley 9488]	Ridley 1900
Garcinia hombroniana Pierre [Ridley 4791]	Ridley 1900
Garcinia nervosa Miq.	Ridley 1900

Table 2 *(Continued)*

Species	Reference
Labiatae	
Hyptis suaveolens (L.) Poit. [Furtado 18344]	–
Ocimum tenuiflorum L. [Furtado 18622]	–
Lauraceae	
Actinodaphne macrophylla (Bl.) Nees [Ridley 9489]	Keng 1990
Litsea umbellata (Lour.) Merr. [Ridley s.n. 2 Mar 1893]	Ridley 1900
Neolitsea zeylanica Merr.	Ridley 1900
Phoebe grandis Merr.	Keng 1990
Leguminosae	
Albizia retusa Benth. [Ridley 4752]	Ridley 1900
Alysicarpus vaginalis (L.) DC.	Ridley 1900
Canavalia cathartica Thou. [Hullett 463]	Ridley 1922
Crotalaria mucronata Desv. [Furtado 18634]	–
Dalbergia candenatensis (Dennst.) Prain [Ridley 4678]	Keng 1990
Dalbergia junghuhnii Benth.	Keng 1990
Derris heptaphylla (L.) Merr. [Hullett 6194]	Ridley 1900
Derris trifoliata Lour. [Furtado 18346]	Ridley 1900
Pithecellobium ellipticum (Bl.) Hassk.	Ridley 1900
Pongamia pinnata (L.) Pierre [Ridley s.n. 1891]	Ridley 1900
Loganiaceae	
Fagraea auriculata Jack	Ridley 1900
Fagraea racemosa Jack ex Wall.	Ridley 1900
Malpighiaceae	
Tristellateia australasiae A. Rich.	Ridley 1900
Malvaceae	
Abutilon indicum (L.) Sweet	Ridley 1900
Hibiscus surattensis L. [Furtado 18623]	Ridley 1900
Thespesia populnea (L.) Sol. ex Correa [Ridley 4624]	Ridley 1900
Melastomataceae	
Diplectria viminalis (Jack) O. Ktze.	Keng 1990
Pogonanthera pulverulenta Bl. [Hullett 391]	Keng 1990
Meliaceae	
Chisocheton erythrocarpus Hiern	Ridley 1900
Chisocheton macrophyllus King [Ridley 4767, isosyntype]	Ridley 1900
Dysoxylum cauliflorum Hiern [Hullett 392]	Ridley 1900
Sandoricum koetjape (Burm. f.) Merr.	Ridley 1900
Menispermaceae	
Cyclea laxiflora Miers	Ridley 1900
Moraceae	
Artocarpus dadah Miq. [Ridley 4721]	Ridley 1900
Ficus fistulosa Reinw. ex Bl.	Ridley 1900

Table 2 *(Continued)*

Species	Reference
Ficus kerkhovenii Val.	Keng 1990
Ficus laevis Bl.	Ridley 1900
Ficus obscura Bl. var. *borneensis* (Miq.) Corner	Ridley 1900
Ficus pellucido-punctata Griff.	Ridley 1900
Myristicaceae	
Knema glaucescens Jack	Ridley 1900
Knema globularia (Lamk.) Warb. [Ridley 4817]	Keng 1990
Myrsinaceae	
Aegiceras corniculatum (L.) Blanco	Ridley 1900
Ardisia singaporensis Ridl. [Ridley 2816, isosyntype]	Ridley 1900
Ardisia villosa Roxb. [Ridley 2809]	Ridley 1900
Myrtaceae	
Eugenia leucoxylon (Korth.) Miq. [Ridley 9486]	Keng 1990
Tristaniopsis whitiana (Griff.) Wilson & Waterhouse [Ridley 4970]	Ridley 1900
Oleaceae	
Olea brachiata (Lour.) Merr.	Ridley 1900
Ochnaceae	
Gomphia serrata (Gaertn.) Kanis	Ridley 1900
Orchidaceae	
Bulbophyllum medusae (Lindl.) Rchb. f.	Ridley 1900
Corymborkis veratrifolia (Reinw.) Bl. [Ridley 2037]	Ridley 1900
Cymbidium finlaysonianum Lindl. [Goodenough s.n. 1894]	–
Grammatophyllum speciosum Bl.	Ridley 1900
Renanthera elongata Lindl.	Ridley 1900
Spathoglottis plicata Bl. [Furtado 18621]	–
Thrixspermum calceolus (Lindl.) Rchb. f. [Goodenough s.n. 23/5/1896]	Ridley 1900
Vanilla griffithii Rchb. f.	Ridley 1900
Palmae	
Caryota mitis Lour. [Goodenough 3148]	–
Licuala spinosa Wurmb [Ridley 3166]	Ridley 1900
Nenga pumila (Mart.) Wendl. [Goodenough s.n. 1890]	–
Orania sylvicola (Griff.) H.E. Moore [Ridley 3146]	Ridley 1900
Pandanaceae	
Pandanus odoratissimus L. f.	Ridley 1900
Pandanus parvus Ridley	Ridley 1900
Passifloraceae	
Passiflora foetida L. [Furtado 18626]	–
Piperaceae	
Piper caninum Bl.	Ridley 1900
Rhamnaceae	
Ventilago malaccensis Ridl.	Keng 1990

Table 2 *(Continued)*

Species	Reference
Rhizophoraceae	
Bruguiera cylindria (L.) Bl. [Ridley 366]	Ridley 1900
Rubiaceae	
Borreria articularis (L. f.) F.N. Will. [Furtado 18339]	–
Borreria laevicaulis (Miq.) Ridl. [Furtado 18343]	Keng 1990
Gaertnera viminea Hook. f. ex Clarke [Ridley 9500]	Ridley 1900
Ixora congesta Roxb.	Ridley 1900
Lasianthus cyanocarpus Jack [Ridley 9499]	Ridley 1900
Morinda umbellata L.	Ridley 1900
Ophiorrhiza singaporensis Ridl.	Ridley 1923
Oxyceros longiflora (Lamk.) Yamazaki [Ridley 9487]	–
Psychotria griffithii Hook. f.	Ridley 1900
Psychotria malayana Jack	Ridley 1900
Psychotria rostrata Bl.	Keng 1990
Uncaria glabrata (Bl.) DC.	Ridley 1900
Urophyllum streptopodium Wall. ex Hook. f. [Hullett 393]	Ridley 1900
Rutaceae	
Clausena excavata Burm. f.	Ridley 1900
Sapindaceae	
Cardiospermum halicacabum L.	Ridley 1900
Lepisanthes rubiginosa (Roxb.) Leenh. [Hullett 386]	Ridley 1900
Mischocarpus sundaicus Bl. [Ridley 9495]	–
Solanaceae	
Datura candida (Pers.) Pasq. – esc. cult.	Ridley 1900
Physalis minima L. [Ridley 367]	Keng 1990
Solanum torvum Sw. [Furtado 18628]	–
Sterculiaceae	
Pterospermum diversifolium Bl. [Ridley 387]	Ridley 1900
Sterculia coccinea Jack	Ridley 1900
Turneraceae	
Turnera ulmifolia L. [Furtado 18633]	–
Urticaceae	
Poikilospermum cordifolium (Borg.-Petr.) Merr.	Ridley 1900
Poikilospermum suaveolens (Bl.) Merr.	Ridley 1900
Verbenaceae	
Clerodendrum inerme (L.) Gaertn.	Keng 1990
Stachytarpheta indica (L.) Vahl [Furtado 18627]	–
Vitex trifolia L.	Keng 1990
Zingiberaceae	
Hornstedtia leonurus (Koenig) Retz. [Ridley 9494]	Holttum 1950

Table 3
The five angiosperm families with the most species for the flora of Singapore (after Turner *et al.* 1990) and the contemporary flora of Pulau Ubin. Total number of species with number of alien species in brackets.

Singapore		**Pulau Ubin**	
Orchidaceae	194 (0)	Gramineae	26 (8)
Rubiaceae	147 (7)	Leguminosae	25 (10)
Euphorbiaceae	127 (13)	Euphorbiaceae	24 (8)
Gramineae	119 (18)	Cyperaceae	19 (1)
Cyperaceae	95 (3)	Compositae	18 (5)

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Oil glands are masked by the cuticle in most specimens, although a scattering from somewhat wetter areas in the the north-east of the range show them. This probably partly reflects intergradation with *C. maritima*.

Hybrids are known with *C. tumescens* and *C. setosa* subsp. *pedicellaris* (see Appendix 1).

Conservation status: Widespread and locally abundant, this species is not considered to be at risk.

Selected specimens (from 100 examined): Queensland: 20.0 km from Powlathanga on track to Toomba, *Blaxell 89/076, Johnson & D'Aubert*, 26 July 1989 (NSW, BRI, CANB); 85.1 km N of Belyando River on Clermont to Charters Towers road, *Hill 3702 & Stanberg*, 22 July 1990 (NSW, BRI, CANB); 56.7 km from Clermont on Charters Towers road, *Hill 3696 & Stanberg*, 22 July 1990 (NSW, BRI, CANB); near Rockhampton, *Simmons 5*, Aug 1937 (BRI, NSW); Mt Morgan, *Henrickson*, 2 Oct 1911 (NSW); 7.8 miles N of Ambrose, *Speck 1782*, 4 Sep 1963 (CANB, NSW); 21.3 km E of Dingo, *Brooker 10227*, 23 May 1989 (CANB, BRI, DNA, NSW); 59 km S of Blackwater on road to Rolleston, *Hill 1331*, 2 Jan 1986 (NSW, BRI); 10 km N of Eidsvold, *Johnson 7138*, 2 June 1971 (NSW); 14 miles NNW of Injune, *Speck 1984*, 1 May 1964 (CANB, NSW); 25.7 km N of Hivesville towards Wigton, *Chippendale 1084 & Brennan*, 14 Sep 1974 (CANB, NSW); 10 km N of Charleville, *Hill 3612 & Stanberg*, 7 Dec 1988 (NSW); 21.5 km S of Nindigully on St George-Mungindi road, *Martensz 1124 & Johnston*, 2 Feb 1977 (BRI, AD, CANB, MEL, NSW); 5.5 km E of Texas on Stanthorpe road, *Brooker 7286*, 3 Mar 1982 (CANB, NSW).

New South Wales: North Western Plains: c. 45 miles from Boggabilla on Boomi road, *K. Wilson et al. 782, 783 & Johnson*, 19 Nov 1974 (NSW); 59 miles N of Walgett, *G. Cunningham & Milthorpe 1996*, 16 Mar 1974 (NSW). North Western Slopes: 4–6 miles [6–10 km] on Inverell road, Warialda, *Maiden & Boorman*, Aug 1905 (NSW 308236); Narrabri to Killarney Gap at 30°09'S 150°00'E, *Johnson 7857*, Nov 1974 (NSW).

18. ACILLP **Corymbia plena** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Polycarparum* combinatione characterum sequentium distinguitur: alabastra floresque magni; fructus permagni summo crassi; folia eis *C. dolichocarpae* similia sed glandulis oleigeris plerumque plusminusve manifestis.

Type: Queensland: 47.3 km from Aramac on Eastmere road, *K.D. Hill 1178 & L.A.S. Johnson*, 20 Aug 1984 (holo NSW; iso BRI, CANB, PERTH).

Tree to 20 m. *Rhizomes* not recorded. *Bark* persistent throughout, evenly tessellated, brown, pale brown or pinkish-brown on freshly broken surfaces. *Cotyledons* c. 12 mm long, c. 17 mm wide; *petioles* c. 8 mm long. *Juvenile leaves* elliptical, setose with bristle-glands but lacking simple hairs, becoming bristle-free about node 5–8, to 12 cm long, to 25 mm wide; *petioles* to 8 mm long. *Intermediate leaves* disjunct, bristle-free, oblong or elliptical to lanceolate, somewhat larger than adult leaves, to 18 cm long, to 40 mm wide; *petioles* to 12 mm long. *Adult leaves* hypostomatic, ± dull above, lanceolate, 7–18 cm long, 10–22 mm wide; *petioles* 9–23 mm long; *intramarginal vein* distinct; *oil glands* small, usually discernible but sometimes ± obscured, regularly distributed. Branchlets and petioles slender, often reddish. *Umbellasters* 7-flowered; *peduncles* 7–16 mm long; *pedicels* 3–6 mm long. *Mature buds* pyriform or broadly clavate, white-scurfy, 12–15 mm long, 7–9 mm diam.; *calyptra* less than half as long as hypanthium, broadly obtuse-conical or hemispherical and apiculate. *Fruits* elongate-ovoid, length mostly more than 1.5 times greater than diameter, white-scurfy, 25–31 mm long, 14–20 mm diam. *Seeds* 9–12 mm long including wing. Fig. 38.

Flowering: Apr–May.

Distinguished by the large buds and flowers as well as the very large, thick-rimmed fruits, which are approached in size in the series only by some examples of *C. novoguinensis*. It is distinguished from the latter by the smaller, thicker, duller adult leaves. It is also readily distinguished in the field from most individuals of *C. dolichocarpa*

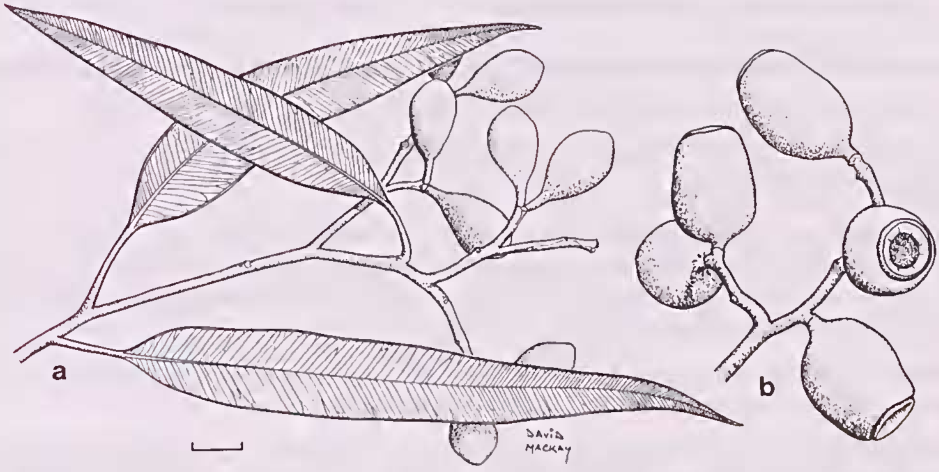

Fig. 38. *C. plena*. a, adult leaves and buds. b, fruits (a from *Brooker 10192*, b from *Hill 1178 & Johnson*). Scale bar = 1 cm.

(which occurs to the east and south) by the presence of regularly distributed visible oil glands in adult leaves (oil glands are usually obscure or very sparsely visible in the latter); as in *C. dolichocarpa* the glands are mostly towards the abaxial surface. Some intergradation occurs in intervening areas (see under *C. dolichocarpa* and Appendix 1). The species has been confused with *C. terminalis*, but differs strikingly in the completely rough and brown (not reddish) bark.

C. plena is rather scattered in distribution, most frequently on deep, red sandy or lateritic soils, but also occurring on sandy alluvial river levees. It is found between Pentland and Hughenden, extending south through a zone running to the east of Barcaldine and south to Tambo (Fig. 37).

Hybrids are recorded with *C. brachycarpa* and *C. terminalis* (Appendix 1).

The epithet is from the Latin *plenus*, full or stout, from the large fruits.

Conservation status: Widespread and locally abundant, this species is not considered to be at risk.

Selected specimens (from 16 examined): Queensland: 7.9 km W of Pentland, *Hill 3717 & Stanberg*, 28 July 1990 (NSW, BRI, CANB); W bank of Torrens Creek between Hughenden and Pentland, *Brooker 10192*, 18 May 1989 (CANB, BRI, DNA, MEL, NSW); 6 km SE of Carmichael homestead, *Thompson BUC159 & Simon*, Apr 1992 (BRI, CANB, NSW); 47.3 km from Aramac on Eastmere road, *Blaxell 89/043, Johnson & D'Aubert*, 25 July 1989 (NSW, BRI, CANB); 6 miles [10 km] SSW of Monkland station, *Adams 1326*, 1 Oct 1964 (CANB, NSW); 200 metres S of Alice River on road to Lochnagar, *Brooker 10439, 10440*, 10 Mar 1990 (CANB, BRI, DNA, MEL, NSW); 86.9 km S of Alpha on Tambo road, *Hill 3880 & Johnson*, 24 May 1991 (NSW, BRI, CANB).

ACIN Series **Porrectae**

Rhizomes present. Bark persistent to smallest branches. Juvenile leaves amphistomatic, becoming bristle-free and disjunct early, no peltate stage. Bristle-glands present before about node 5–7. Adult leaves amphistomatic, almost concolorous, intramarginal vein distinct from margin on upper as well as lower surface. Buds and fruits not scurfy, but fruits with lenticel-like dots. Corolla fused, adhering to calyx at anthesis. Seeds dull to semi-glossy, brown or red-brown, with a terminal wing.

A unispecific series, restricted to the open forests and denser savannah woodlands of the wetter regions of the north-western Northern Territory.

19. ACINNO **Corymbia porrecta** *(S.T. Blake) K.D. Hill & L.A.S. Johnson* **comb. nov.**

Basionym: *Eucalyptus porrecta* S.T. Blake, Austral. J. Bot. 1(2): 251 (1953).

Type citation: 'Type. – Blake 16951 (BRI, CANB, R, A, MEL, NSW); Paratype M. Holtze 1257 (MEL, BRI).'

Type: Northern Territory: near Koolpinyah, *S.T. Blake 16951*, 8 Sep 1946 (holo BRI; iso said to be distributed to A, CANB, K, L, MEL, NSW). The isotype listed as distributed to NSW cannot now be found. One of us (LJ) who was at NSW in the 1950s has no recollection of seeing it therein.

Blakely (1934) regarded material of this species as representing *E. foelscheana* F. Muell., treating *C. foelscheana* itself as *E. leiophloia* Blakely & Jacobs.

The holotype of *E. erubescens* Carr & Carr is a mixed collection including material of *C. porrecta*, but has been lectotypified on the *C. polycarpa* component (discussed under that species).

Tree to 18 m. *Rhizomes* present. *Bark* persistent throughout, evenly tessellated, deep red-brown on freshly broken surfaces. *Cotyledons* not seen. *Juvenile leaves* elliptical to orbicular, setose with bristle-glands only, becoming bristle-free about node 5–7, becoming disjunct about node 10–15, to 8 cm long, 60 mm wide; petioles to 10 mm long. *Intermediate leaves* disjunct, bristle-free, ovate, somewhat larger than adult leaves, to 22 cm long, to 120 mm wide; *petioles* to 30 mm long. *Adult leaves* disjunct, sub-glossy to glossy, almost concolorous, amphistomatic, lanceolate to broad-lanceolate, 12–20 cm long, 30–65 mm wide; *petioles* 18–25 mm long; *intramarginal vein* distinct though very close to the margin on the upper surface; *oil glands* small, scattered. *Umbellasters* 7-flowered; *peduncles* 17–35 mm long; *pedicels* 5–22 mm long. *Mature buds* ovoid or rhomboid to globular, not scurfy, 10–16 mm long, 8–10 mm diam., *calyptra* hemispherical to conical. *Fruits* ovoid to urceolate, not scurfy but with scattered to numerous lenticel-like dots and sometimes becoming somewhat scaly, 18–30 mm long, 15–25 mm diam. *Seeds* 11–13 mm long including wing.

Flowering: Recorded Sep, Oct, Jan.

Distinguished by the broad, concolorous, adult leaves, the orbicular juvenile leaves, and the large fruits with long pedicels.

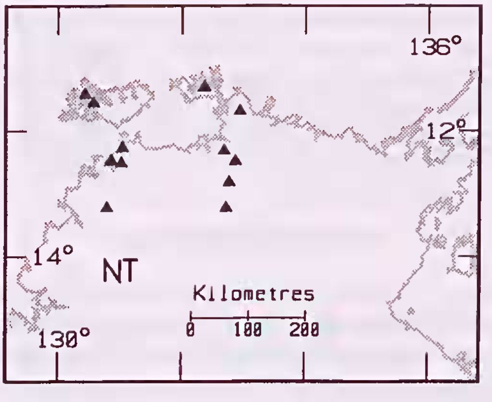

Fig. 39. Distribution of *C. porrecta*.

A sporadic and locally frequent species through the north-western Northern Territory, north of Pine Creek and west of Arnhem Land (Fig. 39). Usually in tall woodland on sandy soils with gravelly laterite, in association with *Eucalyptus (Fibridia) tetrodonta*. Occurrences on the Tabletop Range (Litchfield State Park); however, often on skeletal soils on sandstone; also in association with *E. tetrodonta*.

Conservation status: Frequent over a wide range, not considered to be at risk.

Selected specimens (from 15 examined): Northern Territory: 12.2 miles S of Danger Point, Cobourg Peninsula, *Chippendale NT 8223*, 20 July 1962 (DNA, NSW); Melville Island, 11°32'S 130°33'E, *Dunlop 3440*, 17 Apr 1973 (DNA, CANB, NSW); Shoal Bay road, 14 miles from Darwin, *Allen B 28*, 5 Nov 1933 (NSW); Jim Jim Creek, 13°12'S 132°42'E, *Lazarides 7643*, 17 July 1972 (CANB, BRI, DNA, K, L, NSW, US); Darwin, *G. Hill 344*, 25 Oct 1915 (NSW); 16 km SE of Darwin, *Beadle 211*, 12 Nov 1972 (NSW, UNE); 6.8 km N of 'The Lost City', Litchfield State Park, *Hill 3326, Johnson & Stanberg*, 16 Nov 1988 (NSW, CANB, DNA).

ACIQ Series Arenariae

Rhizomes not recorded. Juvenile leaves shortly petiolate, cordate or subpeltate at some stages, with bristle-glands on both sides and simple hairs beneath. Petals adherent to calyptra at anthesis, free. Style-base sunken. Seeds dull to semi-glossy, brown to red-brown, with a terminal wing. Adult leaves hypostomatic or amphistomatic.

A series of two sharply distinct species with relictual distributions, occurring on sandstone outcrops in tropical Australia (Fig. 21).

20. ACIQQI **Corymbia arnhemensis** *(D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus arnhemensis* D.J. Carr & S.G.M. Carr, Eucalyptus 1: 78 (1985).

Type citation: 'Typus: R.L.Specht 1102, 1 Oct. 1948, in dry watercourse on sandstone scarp, Oenpelli, 12°18' 133°04'. Holo.(AD),iso.(BRI).'

Tree to 15 m, often less. *Rhizomes* not recorded. *Bark* persistent on trunk, thick, deeply regularly tessellated, dark grey-brown, soft, sharply changing to smooth, white or pale grey at top of trunk. Twigs sometimes glaucous. *Cotyledons* 6–9 mm long, 10–12 mm wide; *petioles* 2–5 mm long. *Juvenile leaves* opposite, setose with bristle-glands and bearing simple hairs, linear to lanceolate, to 12 cm long, to 16 mm wide; *petioles* to 7 mm long. *Intermediate leaves* disjunct from about node 30, bristle-free from about node 30, discolorous, often pruinose, linear, becoming oblong or ovate, to 20 cm long, to 40 mm wide; *petioles* to 8 mm long. *Adult leaves* disjunct, distinctly discolorous, hypostomatic, dull, linear to narrow-lanceolate, 8–18 cm long, 7–18 (rarely 25) mm wide; *petioles* 8–21 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, sometimes obscured. *Umbellasters* 7-flowered; *peduncles* 6–16 mm long; *pedicels* 2–11 mm long. *Mature buds* ovoid to pyriform, not scurfy, 6–7 mm long, 4–5 mm diam.; calyptra patelliform, about 1/4 as long as hypanthium, sometimes minutely apiculate; style sunken. *Fruits* ovoid-urceolate with a thin, flared rim and a narrow orifice, rather smooth with small whitish lenticel-like dots, 8–15 mm long, 7–11 mm diam. *Seeds* 6–8 mm long including wing.

Distinguished by the combination: intermediate leaves highly dimorphic, at first linear, later ovate; adult leaves linear to narrow-lanceolate, discolorous, hypostomatic, dull above; bark dark red-brown to grey and persistent to bases of branches, then smooth and whitish; buds and fruits small, with short pedicels and peduncles.

C. arnhemensis generally occurs on skeletal soils in fissures in outcropping sandstone, mainly around the rims of escarpments and associated gorges, but in some cases on residual outcrops.

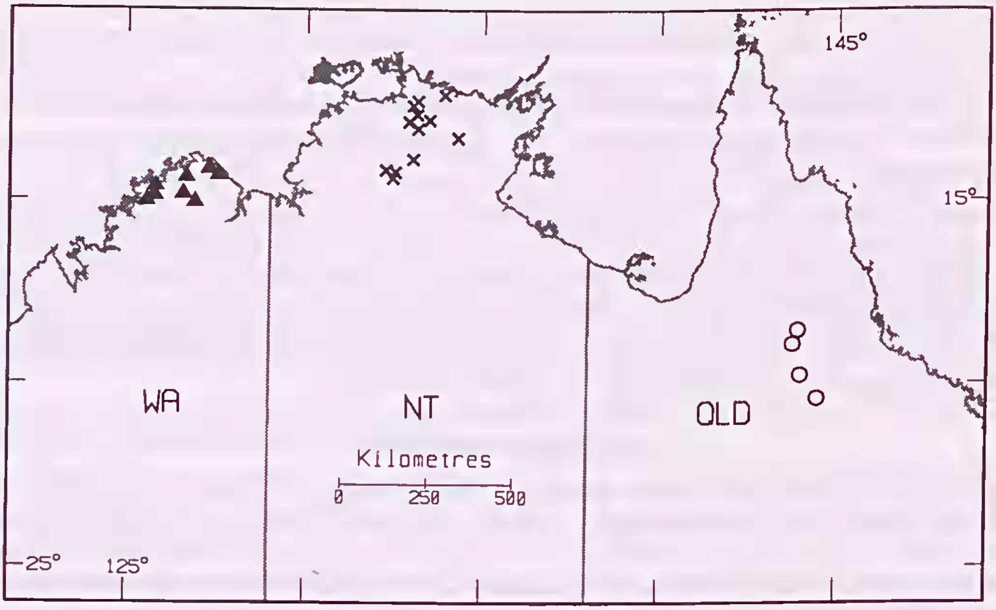

Fig. 40. Distribution of *C. arnhemensis* subsp. *arnhemensis* (cross), *C. arnhemensis* subsp. *monticola* (open circle), *C. arenaria* (triangle).

Two widely disjunct subspecies are recognised.

1 Fruits small (8–13 mm long, 7–9 mm diam.), pedicels short (2–6 mm long), juvenile shoots frequently pruinose .... 20A. subsp. **arnhemensis**

1* Fruits larger (12–15 mm long, 8–11 mm diam.), pedicels longer (5–11 mm long), juvenile shoots not pruinose .... 20B. subsp. **monticola**

20A. ACIQQIA **Corymbia arnhemensis** *(D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson* subsp. **arnhemensis**

Tree to 10 m, often less. *Juvenile leaves* 6–9 mm long, 6–12 mm wide; *petioles* 2–5 mm long. *Intermediate leaves* to 12 cm long, to 40 mm wide; *petioles* to 8 mm long. *Adult leaves* 8–18 cm long, 8–18 (rarely 25) mm wide; *petioles* 9–21 mm long. Coppice shoots and inflorescence branches slightly to markedly pruinose. *Peduncles* 6–12 mm long; *pedicels* 2–6 mm long. *Mature buds* 6–7 mm long, 4–5 mm diam. *Fruits* 8–13 mm long, 7–9 mm diam.

Flowering: (Nov–)Feb–Apr.

Abundant on skeletal soil on the rugged sandstone of the Arnhem Land escarpment, and apparently restricted to that region (Fig. 40). This subspecies is sympatric with *C. oocarpa* in this region, the latter occurring on deeper alluvial sand accumulations in depressions both above and below the escarpment. *C. arnhemensis* subsp. *arnhemensis* is restricted to fissures in outcropping sandstone, mainly around the rim of the escarpment and associated gorges, but in some cases on residual outcrops at the foot of the escarpment.

Conservation status: Restricted to a particular substrate, but locally abundant and reserved in Kakadu National Park, not considered to be at risk.

Selected specimens (from 32 examined): Northern Territory: 78.3 km from Murgenella road on Maningrida road, *Hill 3983 & Stanberg*, 31 Aug 1991 (NSW); E of Oenpelli, *Johnson 8149*, 23 Sep

1975 (NSW); Obiri Rock, *Boland 2189, 2190 & Wardman*, 20 Nov 1984 (CANB, DNA, MEL, NSW, PERTH); Magela Creek, *Dunlop 3356*, 25 Feb 1973 (DNA, ANU, BRI, CANB, K, L, MEL, NSW); Koongarra Saddle, *Hill 3321, Johnson & Stanberg*, 13 Nov 1988 (NSW); East Alligator River headwaters (12°48'S 133°21'E), *Wightman 1384 & Craven*, 31 Mar 1984 (DNA, BRI, CANB, NSW); 42 miles SE of Oenpelli (12°49'S 133°24'E), *Adams 2775*, 10 July 1972 (CANB, BRI, CANB, DNA, K, L, NSW, US); 1 km W of Mt Gilruth, *Olsen 2714*, 6 June 1976 (NSW); 10 km S of Yaimanyi Creek, 137 km S of Maningreda [Maningrida], *Symon 7877*, 25 June 1972 (AD ex ADW, NSW); Edith Falls, *Hill 3295, 3296, Johnson & Stanberg*, 11 Nov 1988 (NSW); Katherine Gorge National Park, Pats Lookout, *Hill 3288, Johnson & Stanberg* (NSW); plateau above Katherine Gorge, on lookout walking track, *Blaxell 88/136 & Wrigley*, 27 July 1988 (NSW, DNA); Katherine Gorge, *Blake 17210*, 13 Oct 1946 (BRI, NSW).

20B. ACIQQIM **Corymbia arnhemensis** *(D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson* subsp. **monticola** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Type: Queensland: Chudleigh Park station, southern Gregory Range, on track to upper Stawell River, *K. Hill 3733 & L. Stanberg*, 29 July 1990 (holo NSW; iso BRI, CANB).

= *Eucalyptus serendipita* Brooker & Kleinig, Field guide to *Eucalyptus* 3: 371 (1994).

Type: Queensland, hills between Robertson and Gilbert Rivers, south-west of Forsayth, *M.I.H. Brooker 11380 & D.A. Kleinig*, 6 Nov 1992 (holo CANB; iso BRI, MEL, NSW).

The treatment of *E. serendipita* by Brooker and Kleinig cited above includes elements of three or possibly four taxa. The type belongs to *C. arnhemensis* subsp. *monticola*, specimens cited include examples of *C. pocillum* and *C. ligans* subsp. *novocastrensis* (which see), and the habit photograph on p. 74 appears to be of *C. porphyritica*. The characteristic dimorphic intermediate foliage of *C. arnhemensis* does not appear to have been noted. Epithets do not carry priority outside the rank of their original publication.

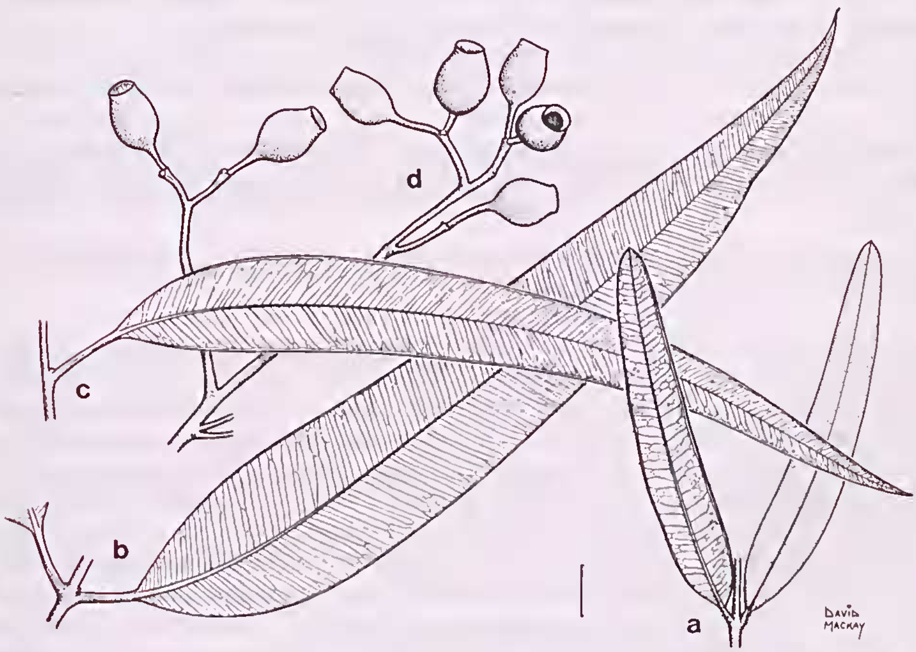

Fig. 41. *C. arnhemensis* subsp. *monticola*. a, juvenile leaf. b, intermediate leaf. c, adult leaf. d, fruits (a, c, d from *Hill 3733 & Stanberg*, b from *Hill 3724 & Stanberg*). Scale bar = 1 cm.

Tree to 15 m. *Juvenile leaves* to 12 cm long, to 16 mm wide, *petioles* to 7 mm long. *Intermediate leaves* to 20 cm long, to 32 mm wide; *petioles* to 11 mm long. *Adult leaves* 8–15 cm long, 7–18 mm wide, *petioles* 8–20 mm long. *Peduncles* 8–16 mm long; *pedicels* 5–11 mm long. *Mature buds* c. 6 mm long, 4 mm diam. *Fruits* 12–15 mm long, 8–11 mm diam. Fig. 41.

Flowering: Not recorded.

Distinguished from subsp. *arnhemensis* by the generally larger buds and fruits with longer pedicels and peduncles, and the absence of pruinosity on juvenile parts and inflorescences.

Restricted to dry sclerophyll forests around the eroded edges of the Newcastle Range plateau, extending south to the Gregory Range and Porcupine Gorge (Fig. 40). Locally abundant on skeletal sands on hard siliceous sandstone. Often associated with *Eucalyptus (Leprolaena) miniata* and *C. gilbertensis.*

The epithet is from the Latin, *mons, montis*, mountain, and *-cola*, a dweller, referring to the occurrence on the Newcastle and Gregory Ranges. The second element of the epithet is a noun, so the epithet is not subject to a change of ending to agree with a generic name with which it may be combined. The stress is on the antepenultimate syllable: 'monTICola'.

Conservation status: Sporadic but locally abundant in remote localities, not considered to be at risk.

Selected specimens (from 8 examined): Queensland: Newcastle Range, 39.7 km from Forsayth towards Einasleigh, *Hill 3589 & Stanberg*, 5 Dec 1988 (NSW); 23.8 km from Forsayth towards Einasleigh, *Hill 3586 & Stanberg*, 5 Dec 1988 (NSW); 14.2 km S of 'Robinhood' on track to 'Percy Vale', *Blaxell 89/100, Johnson & D'Aubert*, 28 July 1989 (NSW); c. 3 km WSW of Warang, White Mountains National Park, *Bean 4640, 4641*, 23 June 1992 (BRI, NSW); Porcupine Gorge, near lookout, *Hill 3724 & Stanberg*, 28 July 1990 (NSW, BRI, CANB).

21. ACIQQU **Corymbia arenaria** *(Blakely) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus arenaria* Blakely, Key Eucalypts: 81 (1934).

Type citation: 'W.A. – King Edward's River.' 'C.A. Gardner, No. 1501, 31st July, 1921.'

Type: Western Australia: King Edward River, *C.A. Gardner 1502*, 31 July 1921 (holo NSW; iso PERTH). The '2' on Gardner's label was misread in copying as 1 in Blakely's citation.

This species was regarded by Blake (1953), who had not seen it in the field, as a variant of *E. dichromophloia* F. Muell.

Tree to 6 m, usually of poor form. *Rhizomes* not recorded. *Bark* persistent except on smaller branches, thick, dark brown, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. Twigs reddish, sometimes lightly glaucous. *Cotyledons* not seen. *Juvenile leaves* opposite, setose with bristle-glands and bearing simple hairs, elliptical, mucronate, to 5 cm long, to 30 mm wide, *petioles* 0–1 mm long. *Intermediate leaves* opposite for many nodes, setose with bristle-glands and bearing simple hairs, cordate, lanceolate to elliptical, apiculate, to 12 cm long, to 55 mm wide; *petioles* 0–1 mm long. *Adult leaves* disjunct, dull, concolorous or weakly discolorous, amphistomatic, narrow-lanceolate to broad-lanceolate, sometimes slightly falcate, acute or acuminate, 6–12 cm long, 8–26 mm wide; *petioles* 10–18 mm long; *intramarginal vein* distinct, within 0.5 mm of margin or less; *oil glands* abundant, regular. *Umbellasters* 7-flowered; *peduncles* terete or slightly winged, 4–12 mm long, *pedicels* 1.5–6 mm long. *Mature buds* ovoid, not scurfy, 3–4 mm long, 2–3 mm diam.;

Diatoms from Marine Environments of Peninsular Malaysia and Singapore

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Abstract

A total of 230 taxa of diatoms belonging to 58 genera were recorded from 12 locations in Peninsular Malaysia and 14 locations in Singapore. The most common genera are *Navicula* and *Nitzschia.*

Introduction

For a long time now the only detailed studies on the marine diatoms of the South-east Asian region have been those by Mann (1925) and Allen & Cupp (1935) on the Philippines Islands and the Java Sea, respectively. More recent studies include those by Takano (1960) who collected from the Arafura and eastern Timor Seas; Wood (1963) who listed many species from the Indonesian waters; Podzorski & Hákansson (1987) on the freshwater and marine diatoms of Palawan, Philippines; and Wah & Wee (1988) on the diatoms of mangrove environments of Singapore and southern Peninsular Malaysia. This paper gives an account on the diatoms of marine environments of Peninsular Malaysia and Singapore.

Materials and Methods

Materials collected for diatoms were from seaweeds obtained from the littoral and sublittoral zones of coastal areas. In addition, sand, molluscs, stones, debris and sediments were also collected. A total of 12 locations in Peninsular Malaysia and 14 locations in Singapore were visited during 1986–87 (Fig. 1). Samples of planktonic diatoms came from the Zoological Raffles Collection of the National University of Singapore. These were collected from the vicinity of Sisters Island in 1968–69. Permanent slides were prepared after the method of Gerloff & Natour (1982), details of which are described in an earlier publication (Wah & Wee, 1988). All taxa were identified from the prepared slides using the classical criteria of size, shape and ornamentation. Relative abundance of the taxa refers to the abundance of the diatoms in the slides referred to. Details of slide numbers giving collection locations and substrata are tabulated in Table I. Slides were deposited in the Cryptogamic Herbarium of the Botany Department, National University of Singapore.

Results

A total of 230 taxa of diatoms belonging to 58 genera were recorded from 12 locations in Peninsular Malaysia and 14 locations in Singapore. Only five genera were

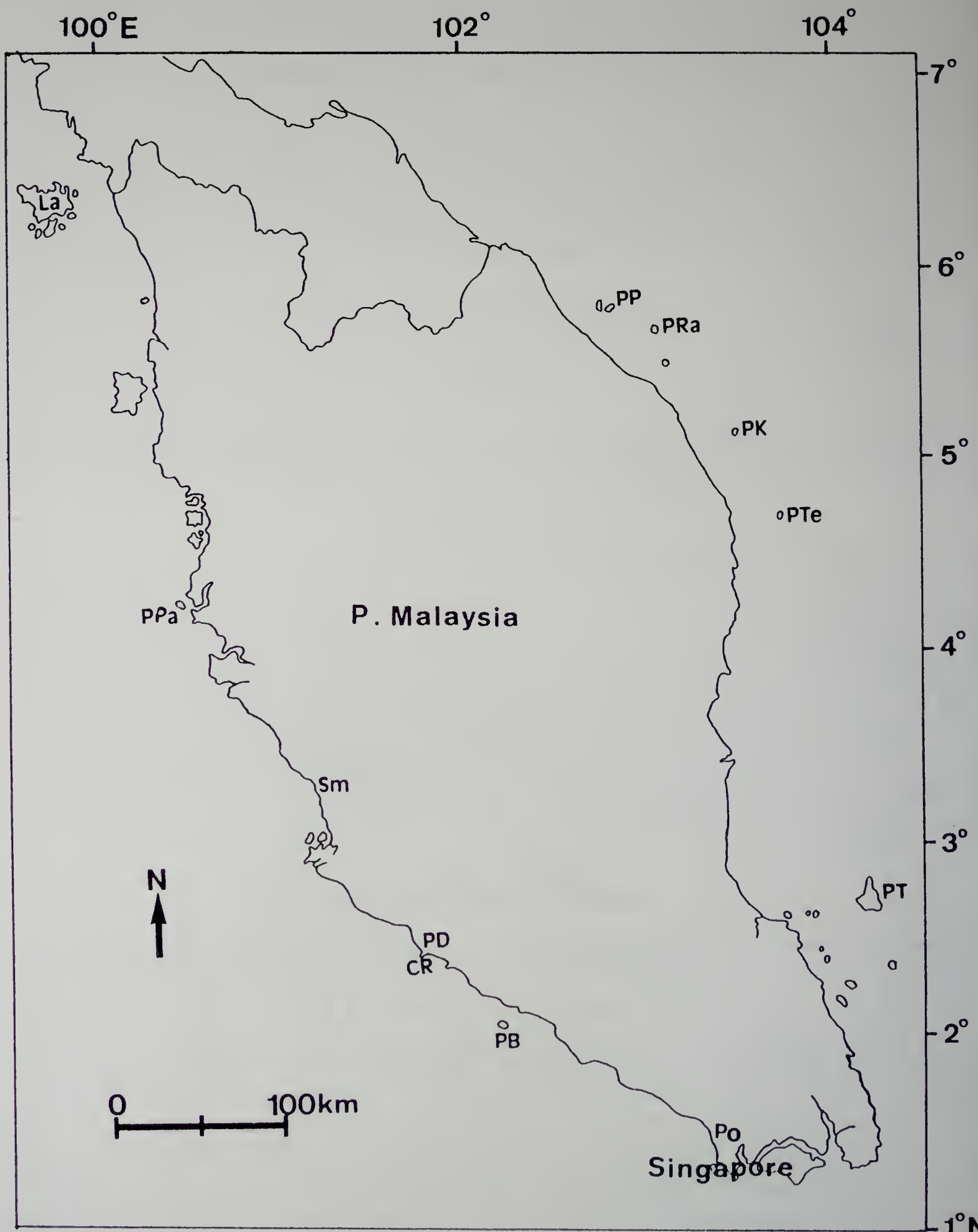


Fig. 1a. Map of Peninsular Malaysia showing collecting sites (CR: Cape Rachado; La: Pulau Langkawi; Po: Pontian; PB: Pulau Besar; PD: Port Dickson; PK: Pulau Kapas; PP: Pulau Perhentian; PPa: Pulau Pangkor; PRa: Pulau Redang; PT: Pulau Tioman; PTe: Pulau Tenggul; Sm: Sementa).

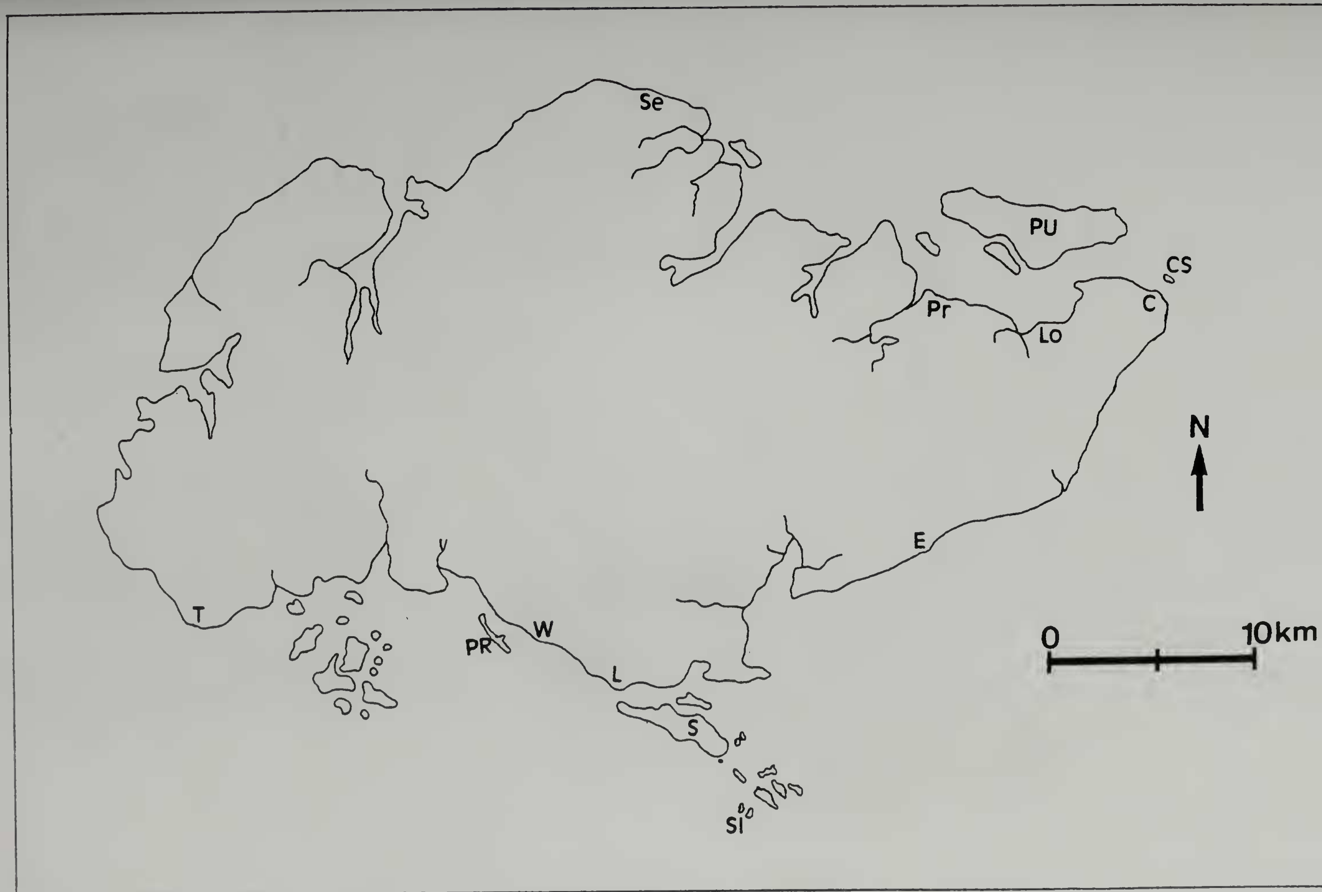


Fig. 1b. Map of Singapore showing collecting sites (C: Changi; CS: Changi seafarm; E: East Coast Park; L: Labrador Park; Lo: Loyang; Pr: Pasir Ris; PR: Pulau Retan Laut; PU: Pulau Ubin; S: Sentosa; Se: Sembawang; SI: Sisters Island; T: Tuas; W: West Coast Park).

Table 1
List of slides giving collection locations and materials collected.

No.	Locations	Materials
1, 2, 3, 4	East Coast Park	seaweeds
12	Changi	seaweeds
17	Kranji	mollusc
19	Loyang	stones
31	Pulau Ubin	roots and algae
33	Pulau Ubin	mud
37, 38	Pulau Ubin	sand
40	Pulau Ubin	reddish sand
43	Pulau Ubin	rock
47, 48	East Coast Park	seaweeds
49	Changi	seaweeds
75	Labrador Park	red algae
79, 80	Labrador Park	sediment
81	Labrador Park	seaweeds
91	Port Dickson	sediment and sand
93	Port Dickson	seaweeds
95	Pasir Ris	sand
100	Pasir Ris	seaweeds
116	Pulau Retan Laut	seaweeds
119, 120	Pulau Tioman	molluscs
122	Pulau Tioman	debris
124	Pulau Tioman	seaweeds
125	Pulau Tioman	water
129, 130	Pulau Tioman	sand
132	Pulau Tioman	black sediment
135, 138	Pulau Tioman	pole
141	Changi	seafarm debris
175	Sembawang	foam
183	Sembawang	seaweeds
257	West Coast Park	seaweeds
259	West Coast Park	sand
273	Sentosa	sand
278	Sentosa	submerged grasses
297	Pontian	sandy mud
315	Around Sisters Island	surface pumping, 16.4.68
317	Around Sisters Island	bottom pumping, 16.4.68
319	Around Sisters Island	surface towing, 21.5.68
321	Around Sisters Island	surface pumping, 14.1.69
323	Around Sisters Island	bottom pumping, 14.1.69
333	Pulau Kapas	seaweeds
335	Pulau Redang	seaweeds
337	Pulau Pangkor	seaweeds
339	Sementa	red algae
341	Pulau Langkawi	water sample
343	Pulau Besar	seaweeds
345	Pulau Tenggul	coral
347	Cape Rachado	seaweeds
350	Pulau Perhentian	seaweeds
351	Tuas	sand
353	Tuas	seaweeds
355	Tuas	filamentous algae
357, 359	Tuas	debris, stone

represented by ten or more taxa, and these were *Amphora* (14), *Diploneis* (21), *Navicula* (29), *Nitzschia* (20) and *Pleurosigma* (11). The most common genera were *Navicula* and *Nitzschia*, the former represented by 27 species and the latter by 19 species.

Systematics

For the sake of convenience, the list of taxa presented here is arranged alphabetically by genus with species and their varieties listed alphabetically within each genus. Figures are given for all taxa.

Achnanthes Bory 1822

A. brevipes var. *intermedia* (Kütz.) Cl. Figs. 2–3

References: Cleve 1894–95, 27(3), p. 193; Hustedt 1959, 7(2), p. 425, figs. 877d, e.
Description: Length 25–42 μm, breadth 9–10 μm, 8–10 striae in 10 μm. United into short filament.
Distribution: Very common. Found on slides 1, 135, 257, 339, 347, 353.
Comments: A cosmopolitan species.

A. hauckiana Grun. Figs. 4–5

References: Cleve 1894–95, 27(3), p. 190; Patrick & Reimer 1966, p. 267, pl. 17, figs. 25–32.
Description: Length 16–25 μm, breadth 8–10 μm, 7–10 striae in 10 μm.
Distribution: Common. Found on slides 125, 353.
Comments: A cosmopolitan species. Freshwater to brackish.

A. lewisiana Patr. Figs. 6–7

References: Patrick & Reimer 1966, p. 266, pl. 17, figs 19, 20.
Description: Length 14 μm, breadth 6 μm, 15 striae in 10 μm.
Distribution: Common. Found on slides 273, 343, 353, 355.
Comments: Freshwater species.

A. longipes Ag. Figs. 8–9

References: Cleve 1894–95, 27(3), p. 195; Hendey 1964, p. 174, pl. 28, figs. 1–6; pl. 42, fig. 2.
Description: Length 62–69 μm, breadth 11–14 μm, 6–7 costae and 9–10 striae in 10 μm. Solitary or joined into filament; attached by mucous stipe.
Distribution: Very common. Found on slides 12, 116.
Comments: A cosmopolitan species.

Actinocyclus Ehrenb. 1838

A. ehrenbergii var. *sparsa* (Greg.) Hust. Fig. 10

References: Hendey 1964, p. 84; Foged 1984, p. 15, pl. 19, fig. 3.
Description: Diameter 37–66 μm, 5–6 areolae and 9–11 marginal striae in 10 μm.
Distribution: Common. Found on slides 48, 119, 124, 138.
Comments: A cosmopolitan species.

A. octonarius Ehrenb Fig. 11

References: Hendey 1964, p. 83, pl. 24, fig. 3; Priddle & Fryxell 1985, p. 108.
Description: Diameter 60 μm, 7 areolae and 16 marginal striae in 10 μm.

Distribution: Not common. Found on slides 95, 339.
Comments: A cosmopolitan species.

A. platensis Müll. Melchers. Fig. 12

References: Hendey 1958, p. 43, pl. 5, figs. 1, 2.
Description: Diameter 56–77 μm, 20 marginal striae in 10 μm.
Distribution: Common. Found on slide 3.

Actinoptychus Ehrenb. 1839

A. senarius (Ehrenb.) Ehrenb. Fig. 13

References: Hendey 1964, p. 95, pl. 23, figs 1 and 2; Priddle & Fryxell 1985, p. 110, fig. A.
Description: Diameter 39 μm.
Distribution: Not common. Found on slides 4, 79, 116, 323, 343.
Comments: A cosmopolitan species.

Amphora Ehrenb. 1840

A. acutiuscula Kütz. Figs. 14–15

References: Prowse 1962, p. 55, pl. 17, figs. e–f, n, q, v–w; pl. 18, fig. b; Patrick & Reimer 1975, p. 77, pl. 14, figs. 9, 10.
Description: Length 35–55 μm, breadth 6–13 μm, 11–12 dorsal, 18–20 ventral striae in 10 μm.
Distribution: Common. Found on slides 12, 17, 43, 297.
Comments: A freshwater species.

A. angusta var. *eulensteinii* Grun. Fig. 16

References: Cleve 1894–95, 27(3), p. 135.
Description: Length 81 μm, breadth 15 μm, 11 dorsal and 14 ventral striae in 10 μm.
Distribution: Not common. Found on slides 100, 357.
Comments: A cosmopolitan species.

A. angusta var. *oblongella* Grun. Fig. 17

References: Cleve 1894–95, 27(3), p. 135.
Description: Length 52–57 μm, breadth 8–10 μm, 12–15 striae in 10 μm.
Distribution: Rare. Found on slides 183, 353.

A. angusta var. *ventricosa* (Greg.) Cl. Fig. 18

References: Cleve 1894–95, 27(3), p. 135; Navarro 1982, p. 31, pl. 20, figs. 1–2.
Description: Length 49–58 μm, breadth 10–13 μm, 14–15 striae in 10 μm.
Distribution: Common. Found on slides 335, 355.

A. coffeiformis (Ag.) Kütz. Fig. 19

References: Prowse 1962, p. 56, pl. 17, figs. h, o.
Description: Length 30–33 μm, breadth 6–7 μm, 18–20 striae in 10 μm.
Distribution: Not common. Found on slides 1, 257, 335. Freshwater to brackish.
Comments: A cosmopolitan species.

A. crassa Greg. Fig. 20

References: Hendey 1964, p. 262. Foged 1975, p. 10, pl. 36, fig. 10.
Description: Length 132 μm, breadth 18 μm, 5 dorsal, 6 ventra costae in 10 μm.
Distribution: Rare. Found on slide 93.
Comments: A cosmopolitan species.

A. decipiens Cl. Fig. 21

References: Cleve 1894–95, 27(3), p. 108, pl. V, figs. 16–18.
Description: Length 41 μm, breadth 17 μm, 12 striae in 10 μm.
Distribution: Rare. Found on slide 12.

A. graeffi var. *minor* Perag. Fig. 22

References: Hendey 1964, p. 263, pl, 37, fig. 8.
Description: Length 38 μm, breadth 9 μm, 11–12 striae in 10 μm.
Distribution: Rare. Found on slides 2, 12.

A. holsatica Hust. Figs. 23–26

References: Caljon 1983, p. 119, pl. 21, figs. 2–8.
Description: Length 18–42 μm, breadth at girdle view 8–14 μm and at valve view 5 μm, 12–20 striae in 10 μm.
Distribution: Very common. Found on slides 1, 12, 122, 257, 259, 273, 335, 337, 339, 341, 343, 347, 350, 353.
Comments: A cosmopolitan species. Freshwater to brackish.

A. ostrearia Bréb Fig. 27

References: Cleve 1894–95, 27(3), p. 129.
Description: Length 58 μm, breadth 15 in valve view, 38 μm in girdle view, 11–12 striae in 10 μm.
Distribution: Rare. Found on slide 38.
Comments: A cosmopolitan species. Freshwater to marine.

A. proteus Greg. Fig. 28

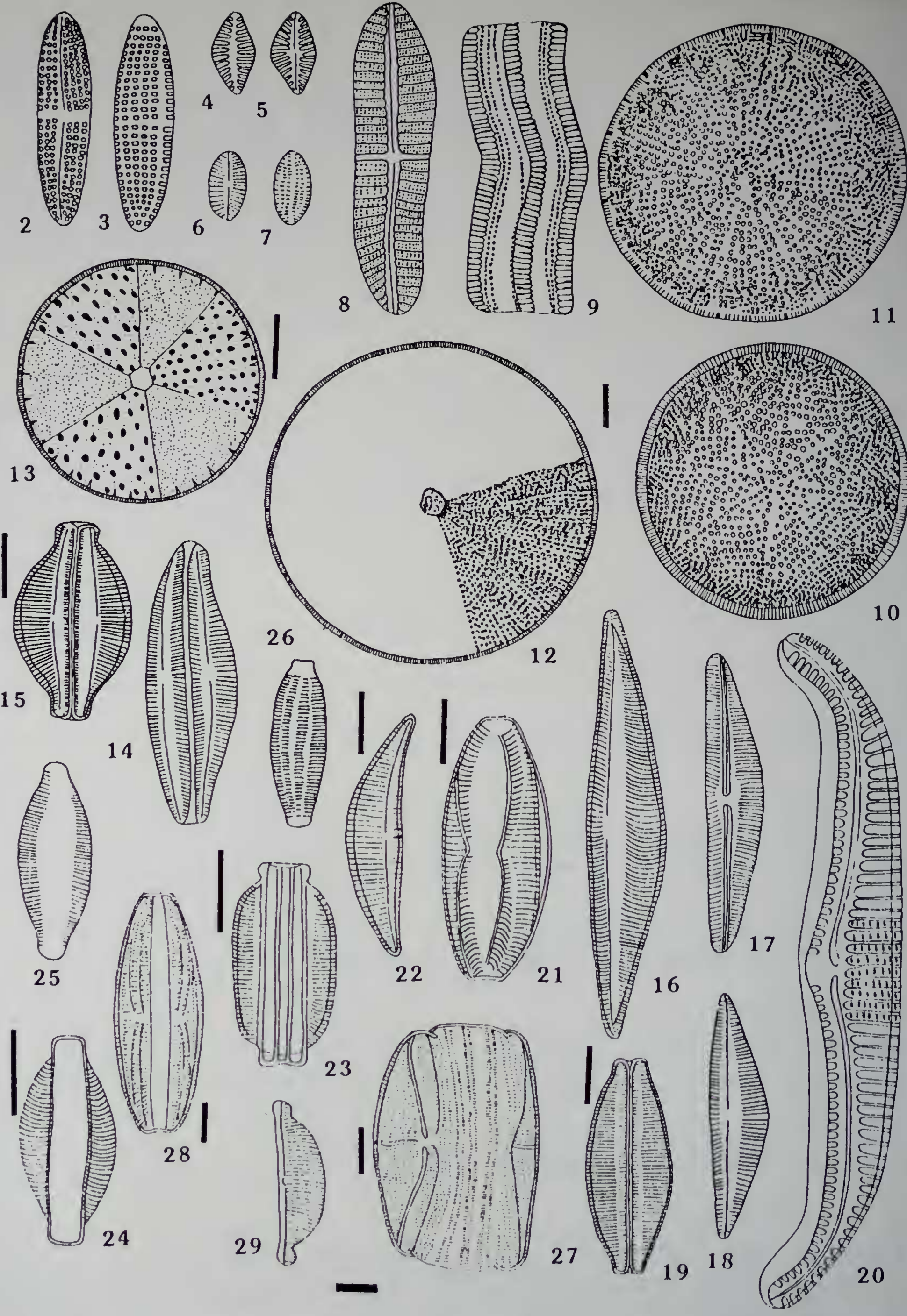
References: Prowse 1962, p. 58, pl. 17, fig. u; pl. 18, fig. a; Cleve 1894–95, 27(3), p. 103.
Description: Length 56 μm, breadth 8 in valve view, 20 μm in girdle view, 9–12 striae in 10 μm.
Distribution: Rare. Found on slide 3.
Comments: A cosmopolitan species.

A. turgida Greg. Fig. 29

References: Cleve 1894–95, 27(3), p. 123; Hendey 1964, p. 264.
Description: Length 32 μm, breadth 9–10 μm, 15 striae in 10 μm.
Distribution: Rare. Found on slides 273, 333, 341, 351.
Comments: A cosmopolitan species. Marine to brackish.

A. valida Perag. Fig. 30

References: Cleve 1894–95, 27(3), p. 102.
Description: Length 82 μm, breadth 16–18 μm in valve, 50 μm in girdle view, 7 striae in 10 μm.
Distribution: Rare. Found on slide 124.



Figs. 2–29 (horizontal common scale bar and those of Figs. 12, 13, 15, 19, 21–24, 27 and 28 = 10 μm)

Figs. 2–3. *Achnanthes brevipes* var. *intermedia*, raphe valve and rapheless valve. Figs. 4–5. *A. hauckiana*, raphe valve and rapheless valve. Figs. 6–7 *A. lewisiana*, raphe valve and rapheless valve. Figs. 8–9. *A. longipes*, raphe valve and girdle view. Fig. 10. *Actinocyclus ehrenbergii* var. *sparsa*. Fig. 11. *A. octonarius*. Fig. 12. *A. platensis*. Fig. 13 *Actinoptychus senarius*. Figs. 14–15. *Amphora acutiuscula*. Fig. 16. *A. angusta* var. *eulensteinii*. Fig. 17. *A. angusta* var. *oblongella*. Fig. 18. *A. angusta* var. *ventricosa*. Fig. 19. *A. coffeiformis*. Fig. 20. *A. crassa*. Fig. 21. *A. decipiens*. Fig. 22. *A. graeffi* var. *minor*. Figs. 23–26. *A. holsatica*. Fig. 27 *A. ostrearia*. Fig. 28. *A. proteus*. Fig. 29. *A. turgida*.

A. wisei (Salah) Simonsen. Fig. 31

References: Foged 1975, p. 12, pl. 26, fig. 11.
Description: Length 14 μm, breadth 5 μm, 16 striae in 10 μm.
Distribution: Rare. Found on slide 273.
Comments: A cosmopolitan (?) species.

Asterionella Hassall 1855

A. japonica Cl. & Möll. Fig. 32

References: Cupp 1943, p. 188, fig. 138; Hendey 1964, p. 158, pl. 21, fig. 1.
Description: Length 92–104 μm, inflated length 22–24 μm, inflated breadth 11–12 μm.
Distribution: Not common. Found on slide 321.

Bacillaria Gmelin 1788

B. paradoxa var. *tumidula* Grun. Fig. 33

References: Navarro 1982, p. 51.
Description: Length 106–149 μm, breadth 10–13 μm, 15–20 striae, 7-9 keel puncta in 10 μm.
Distribution: Common. Found on slide 2.
Comments: A cosmopolitan species. Freshwater to marine.

Bacteriastrum Schadbolt 1853

B. delicatulum Cl. Fig. 34

References: Gran & Angst 1931, p. 463, fig. 46a–b; Hendey 1964, p. 139, pl. 6, fig. 2.
Description: Diameter 16 μm, 9 bristles. United to form chains.
Distribution: Not common. Found on slide 317.
Comments: Common in temperate waters.

B. elongatum Cl. Fig. 35

References: Cupp 1943, p. 99, fig. 57; Hendey 1964, p. 139, pl. 6, fig. 3.
Description: Diameter 14 μm, 9 bristles.
Distribution: Not common. Found on slide 339.
Comments: Common in tropical seas.

B. hyalinum Lauder. Fig. 36

References: Cupp 1943, p. 96, fig. 56(A); Hendey 1964, p. 139, pl. 6, fig. 1.
Description: Diameter 24–39 μm, 14–27 bristles. United to form chains.
Distribution: Common. Found on slide 317.

Biddulphia Gray 1821

B. biddulphiana (Smith) Boyer (*B. pulchella* Gray.). Figs. 40–42

References: Hendey 1964, p. 101, pl. 25, fig. 1.
Description: Length 76–101 μm, breadth 69–82 μm in pervalvar axis; length 77–90 μm, breadth 38–58 μm in top view. Colonial, united with their processes to form short chains.
Distribution: Common. Found on slides 12, 355.
Comments: A cosmopolitan species.

B. mobiliensis (Bailey) Grun. Fig. 37

References: Gran & Angst 1931, p. 490, fig. 74; Cupp 1943, p. 153, fig. 110; Hendey 1964, p. 104, pl. 22, fig. 3.
Description: Length 69 μm in apical axis, breadth 44 μm, 11 striae in 10 μm. Solitary or in chains.
Distribution: Rare. Found on slide 323.

B. petitiana (Leud.-Fortm.) Mann. Figs. 38–39

References: Mann 1925, p. 43, pl. 10, figs. 4, 5.
Description: Length 70 μm in pervalvar axis; length 66 μm, breadth 38 μm in top view.
Distribution: Rare. Found on slide 75.

B. recticulata Roper. Fig. 43

References: Boyer 1926–27, p. 128, Hendey 1958, p. 48.
Description: Length 88–96 μm, breadth 68–96 μm in pervalvar axis (girdle view).
Distribution: Rare. Found on slide 333.
Comments: A cosmopolitan species (?).

B. vesiculosa (Ag.) Boyer. Fig. 44

References: Lebour 1930, p. 181, pl. 4, fig. 1.
Description: Length 91–104 μm, breadth 52 μm in pervalvar axis (girdle view).
Distribution: Rare. Found on slides 4, 278.

Caloneis Cleve 1891

C. alpestris (Grun.) Cl. Fig. 45

References: Patrick & Reimer 1966, p. 587, pl. 54, fig. 9.
Description: Length 73 μm, breadth 15 μm, 20 striae in 10 μm.
Distribution: Rare. Found on slide 12.

C. bacillum (Grun.) Cl. Fig. 46

References: Cleve-Euler 1955, 5(4), p. 102, fig. 1147 a–c; Patrick & Reimer 1966, p. 586, pl. 54, fig. 8.
Description: Length 21–25 μm, breadth 10–12 μm, 21–23 striae in 10 μm.
Distribution: Not common. Found on slides 341, 350.
Comments: A cosmopolitan species. Freshwater.

C. egena (A. Sch.) Cl. Fig. 47

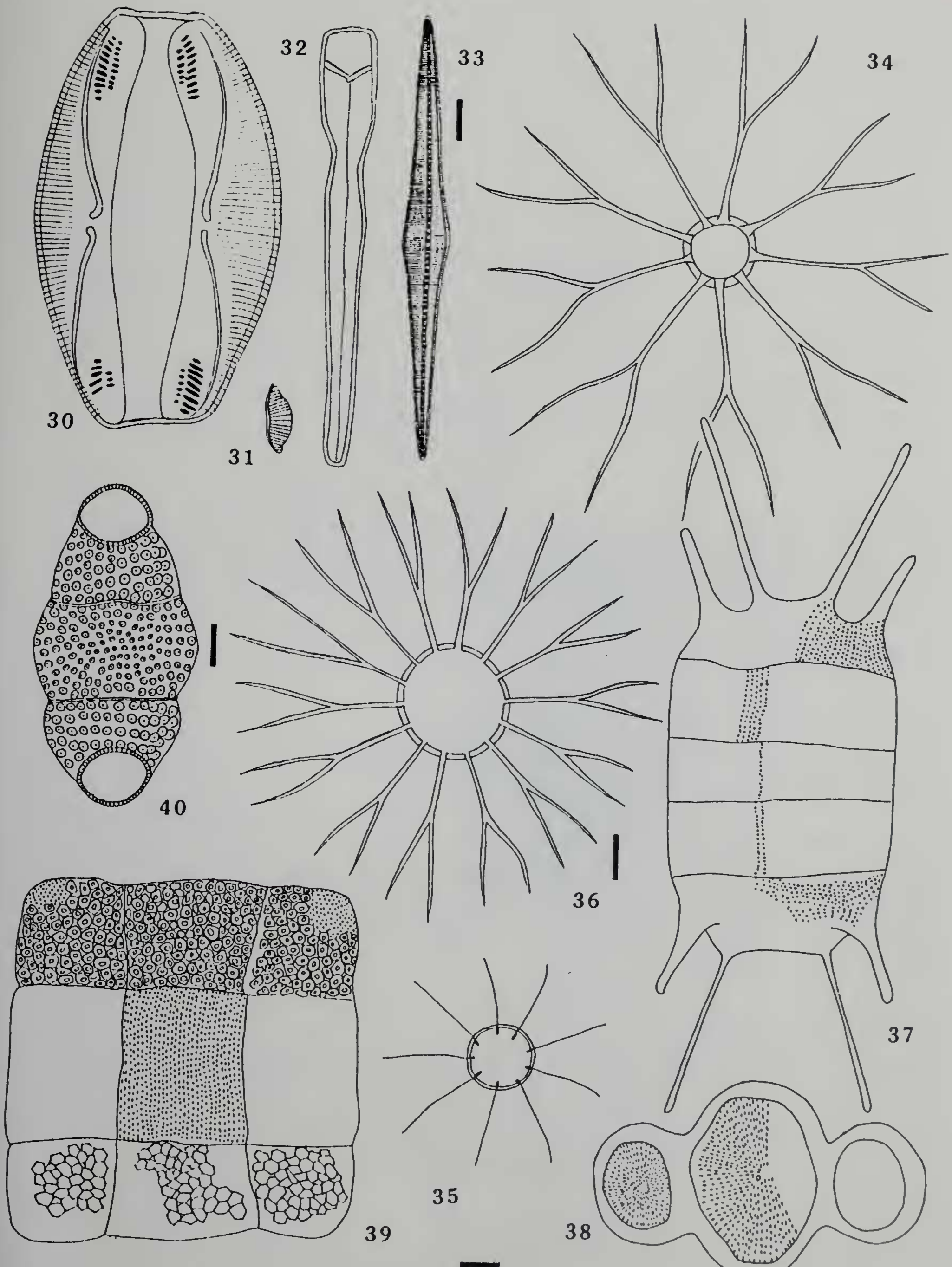
References: Cleve 1894–95, 26(2) p. 66; Foged 1984, p. 24, pl. 44, fig. 10.
Description: Length 25 μm, breadth 6 μm.
Distribution: Rare. Found on slide 345.

C. liber (W. Sm.) Cl. Fig. 48

References: Cleve 1894–95, 26(2) p. 54; Hendey 1964, p. 229, pl. 29, fig. 2.
Description: Length 39 μm, breadth 11 μm, 18 striae in 10 μm.
Distribution: Rare. Slide 31.

C. linearis (Grun.) Boyer. Fig. 49

References: Hendey 1964, p. 230, pl. 29, fig. 3; Foged 1984, p. 26, pl. 44, figs. 4, 5.



Figs. 30–40 (horizontal common scale bar and those of Figs. 33, 36 and 40 = 10 μm)

Fig. 30. *Amphora valida.* Fig. 31. *A. wisei.* Fig. 32. *Asterionella japonica.* Fig. 33. *Bacillaria paradoxa* var. *tumidula.* Fig. 34. *Bacteriastrum delicatulum.* Fig. 35. *B. elongatum.* Fig. 36. *B. hyalinum.* Fig. 37. *Biddulphia mobiliensis*, girdle view. Figs. 38–39. *B. petitiana*, valve view and girdle view. Fig. 40. *B. biddulphiana*, valve view.

Description: Length 48 μm, breadth 8 μm.
Distribution: Not common. Found on slide 345.
Comments: A cosmopolitan species.

Campylodiscus Ehrenb. 1841

C. fastuosus Ehrenb. Fig. 50

References: Hendey 1964, p. 290, pl. 40, fig. 13.
Description: Diameter 54–68 μm.
Distribution: Not common. Found on slides 141, 339, 343, 345, 357.
Comments: Common on sandy beaches of all North Sea coasts (Hendey, 1964).

C. hypodromus Brun & Tempére. Fig. 51

References: Hendey 1964, p. 291.
Description: Diameter 62–113 μm, 2–3 costae in 10 μm.
Distribution: Rare. Found on slide 345.

C. ralfsii W. Sm. Fig. 52

References: Hendey 1970, p. 161, pl. 5, fig. 53; 1964, p. 291.
Description: Diameter 28–56 μm, 2–3 costae in 10 μm.
Distribution: Not common. Found on slides 79, 345, 347.

Chaetoceros Ehrenb. 1844

C. danicum Cl. Fig. 53

References: Hendey 1964, p. 122, pl. 10, fig. 5.
Description: Diameter 25–31 μm. Solitary or in chains.
Distribution: Common. Found on slide 317.

C. lorenzianum Grun. Fig. 54

References: Gran 1905, p. 76, fig. 90; Hendey 1964, p. 124, pl. 26, fig. 1.
Description: Diameter 17 μm. Solitary or in chains.
Distribution: Not common. Found on slide 323.
Comments: A cosmopolitan species.

C. peruvianum Brightw. Fig. 55

References: Hendey 1964, p. 123, pl. 9, fig. 3; Priddle & Fryxell 1985, p. 40.
Description: Diameter 30 μm. Solitary or in chains.
Distribution: Not common. Found on slide 323.
Comments: A cosmopolitan species.

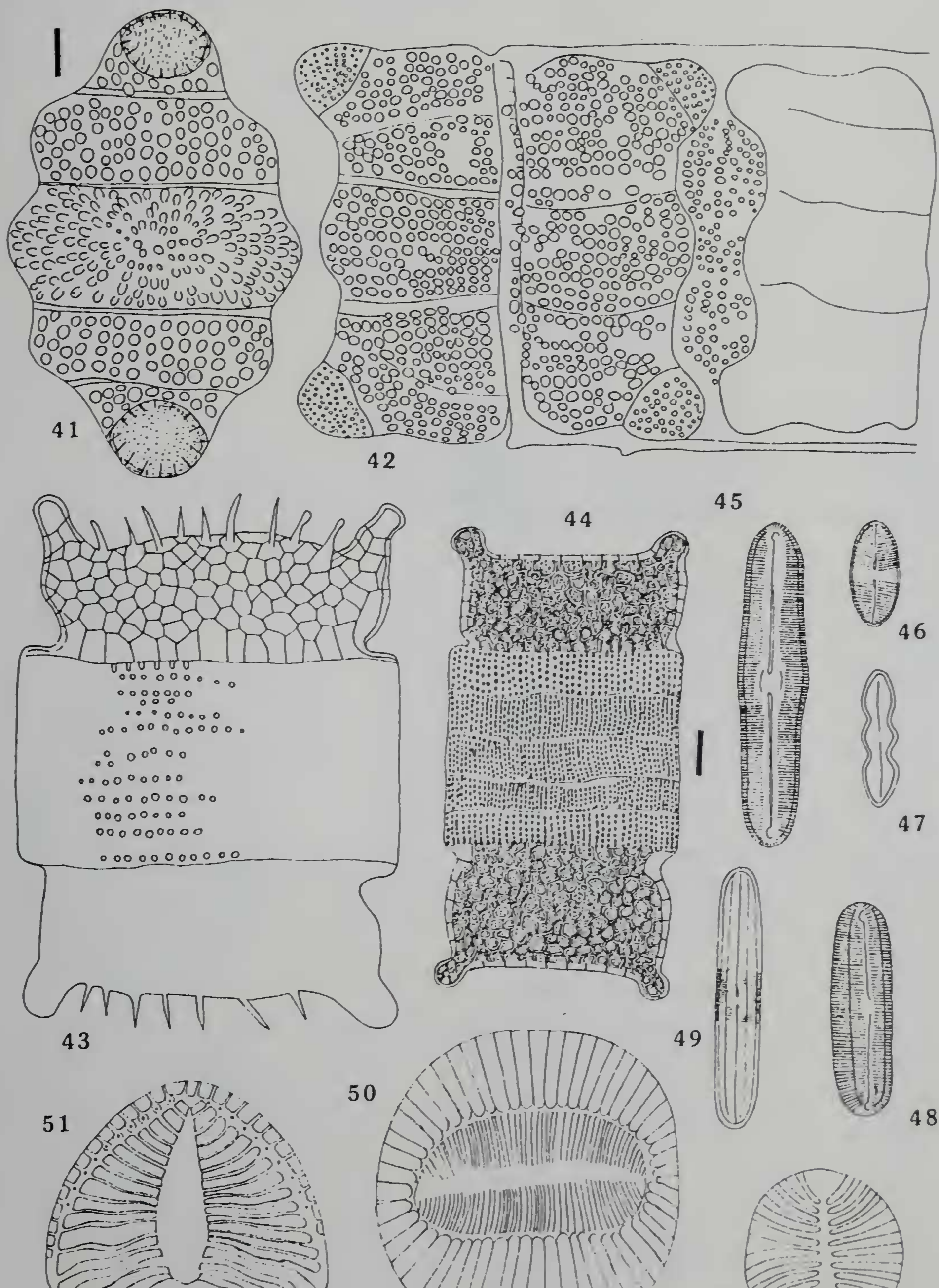
C. tetrastichon Cl. Fig. 56

References: Hendey 1964, p. 123, pl. 11, fig. 1.
Description: Diameter 16 μm. United to form chains.
Distribution: Rare. Found on slide 323.

Climacosphenia Ehrenb. 1841

C. moniligera Ehrenb. Figs. 57–58

References: Cupp 1943, p. 178, fig. 128.



Figs. 41–52 (horizontal common scale bar and those of Figs. 41, 44 = 10 μm)

Figs. 41–42. *Biddulphia biddulphiana*, valve view and girdle view. Fig. 43. *B. recticulata*, girdle view. Fig. 44. *B. vesiculosa*, girdle view. Fig. 45. *Caloneis alpestris*. Fig. 46. *C. bacillum*. Fig. 47. *C. egena*. Fig. 48. *C. liber*. Fig. 49. *C. linearis*. Fig. 50. *Campylodiscus fastuosus*. Fig. 51. *C. hypodromus*. Fig. 52. *C. ralfsii*.

Description: Length 295–493 μm, broadest breadth 29–32 μm, 18–19 striae in 10 μm. Solitary or in fan-shaped colonies.
Distribution: Common. Found on slides 1, 116, 343.
Comments: A cosmopolitan species. Common in warm seas.

Cocconeis Ehrenb. 1838

C. dirupta Greg. Fig. 59

References: Hustedt 1959, 7(2), p. 354, fig. 809; Cleve-Euler 1953, 4(5), p. 12. fig. 499.
Description: Length 42–52 μm, breadth 28–35 μm, 17–20 striae in 10 μm.
Distribution: Common. Found on slides 175, 257, 335, 343, 350, 353.
Comments: A cosmopolitan species.

C. disculoides Hust. Fig. 60

References: Hendey 1964, p. 178, pl. 28, figs. 21, 22.
Description: Length 19–22 μm, breadth 11–13 μm, 8 costae in 10 μm.
Distribution: Not common. Found on slides 1, 93, 124, 257, 341, 350.

C. heteroidea Hantz. Fig. 61

References: Cleve 1894–95, 27(3), p. 178; Hustedt 1959, 7(2), p. 356, fig. 811; Foged 1984, p. 29. pl. 31, fig. 6.
Description: Length 48–64 μm, breadth 38–50 μm, 17–18 striae in 10 μm.
Distribution: Common. Found on slides 273, 278, 335, 350, 357.
Comments: A cosmopolitan species. Mainly in tropical seas.

C. pelta Schmidt. Fig. 62

References: Hustedt 1959, 7(2), p. 361, fig. 815; Cleve-Euler 1953, 4(5), p. 13, fig. 502.
Description: Length 25 μm, breadth 17 μm, 18 striae in 10 μm.
Distribution: Rare. Found on slide 12.

C. placentula var. *euglypta* (Ehrenb.) Cl. Fig. 63

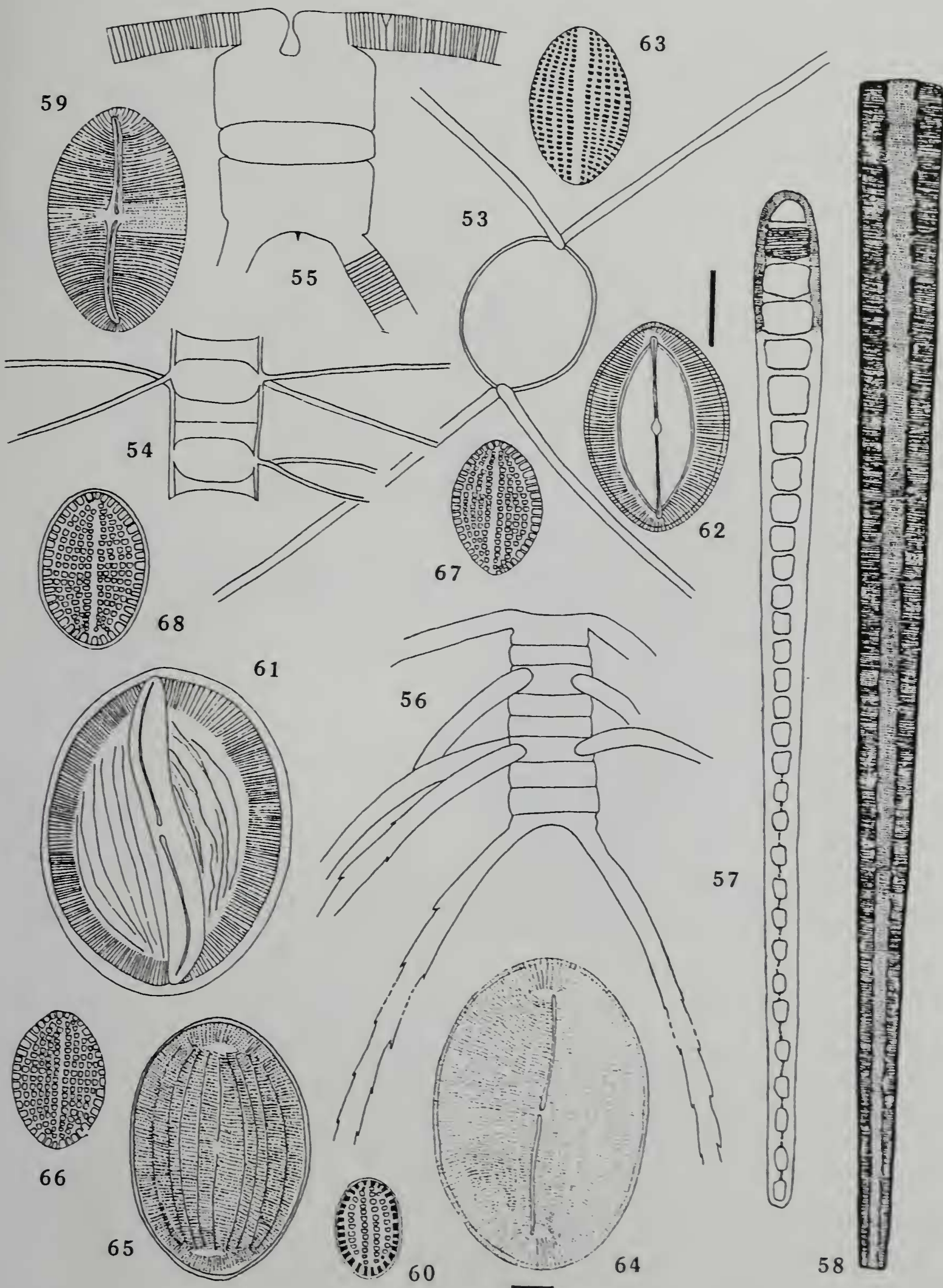
References: Cleve 1894–95, 27(3), p. 170; Patrick & Reimer 1966, p. 241, pl. 15, fig. 8.
Description: Length 17–19 μm, breadth 10–12 μm, 19 lower, 17 upper striae in 10 μm.
Distribution: Common. Found on slides 1, 12, 130, 339, 347, 350.
Comments: A cosmopolitan species. Freshwater to brackish to marine.

C. pseudomarginata var. *intermedia* Grun. Figs. 64–65

References: Cleve 1894–95, 27(3), p. 178; Hendey 1964, p. 179, pl. 28, fig. 20.
Description: Length 46–63 μm, breadth 32–46 μm, 11–17 striae in 10 μm.
Distribution: Common. Found on slide 2, 257, 337, 339, 343, 347.
Comments: A cosmopolitan species.

C. speciosa Greg. Figs. 66–67

References: Cleve-Euler 1953, 4(5), p. 7, fig. 489f, g; Hendey 1964, p. 180, pl. 28, fig. 18.
Description: Length 26 μm, breadth 17–18 μm, 5–7 striae in 10 μm.
Distribution: Common. Found on slides 130, 257, 335.



Figs. 53-68 (horizontal common scale bar and that of Fig. 62 = 10 μm)

Fig. 53. *Chaetoceros danicum*, valve view. Fig. 54. *C. lorenzianum*. Fig. 55. *C. peruvianum*. Fig. 56. *C. tetrastichon*. Figs. 57-58. *Climacosphenia moniligera*. Fig. 59. *Cocconeis dirupta*. Fig. 60. *C. disculoides*. Fig. 61. *C. heteroidea*. Fig. 62. *C. pelta*. Fig. 63. *C. placentula* var. *euglypta*. Figs. 64-65. *C. pseudomarginata* var. *intermedia*. Figs. 66-67. *C. speciosa*. Fig. 68. *C. sublittoralis*.

C. sublittoralis Hend. Fig. 68

References: Hendey 1964, p. 181, pl. 28, figs. 14–17.
Description: Length 24–34 μm, breadth 10–22 μm, 5–6 lower, 6–7 upper areolae in 10 μm.
Distribution: Rare. Found on slide 33, 119.

Coscinodiscus Ehrenb. 1838

C. argus Ehrenb. Fig. 69

References: Prowse 1962, p. 8, pl. 1, figs. j, l–m.
Description: Diameter 64–100 μm, 5 small and 3 large areolae in 10 μm.
Distribution: Very common. Found on slides 12, 79, 81, 124, 359.

C. decipiens Grun. Fig. 70

References: Prowse 1962, p. 8, pl. 3, fig. c.
Description: Diameter 14–34 μm.
Distribution: Very common. Found on slides 12, 79, 273, 278.

C. decrescens Grun. Fig. 71

References: Hustedt 1930, 7(1), p. 430, fig. 233; Hendey 1964, p. 77.
Description: Diameter 34 μm, 4 areolae in 10 μm in the middle.
Distribution: Rare. Found on slide 120.

C. marginatus Ehrenb. Fig. 72

References: Hendey 1964, p. 78, pl. 22, fig. 2.
Description: Diameter 72–78 μm, 9–10 striae in 10 μm.
Distribution: Very common. Found on slides 321, 355.

C. nodulifer Schmidt. Figs. 73–74

References: Allen & Cupp 1935, p. 116, figs. 9, 9a; Hendey 1964, p. 77, pl. 22, fig. 10.
Description: Diameter 31–100 μm, 4–8 marginal striae in 10 μm.
Distribution: Very common. Found on slides 1, 120, 124, 129, 138, 351, 355, 359.
Comments: A cosmopolitan species.

C. oculus-iridus Ehrenb. Fig. 75

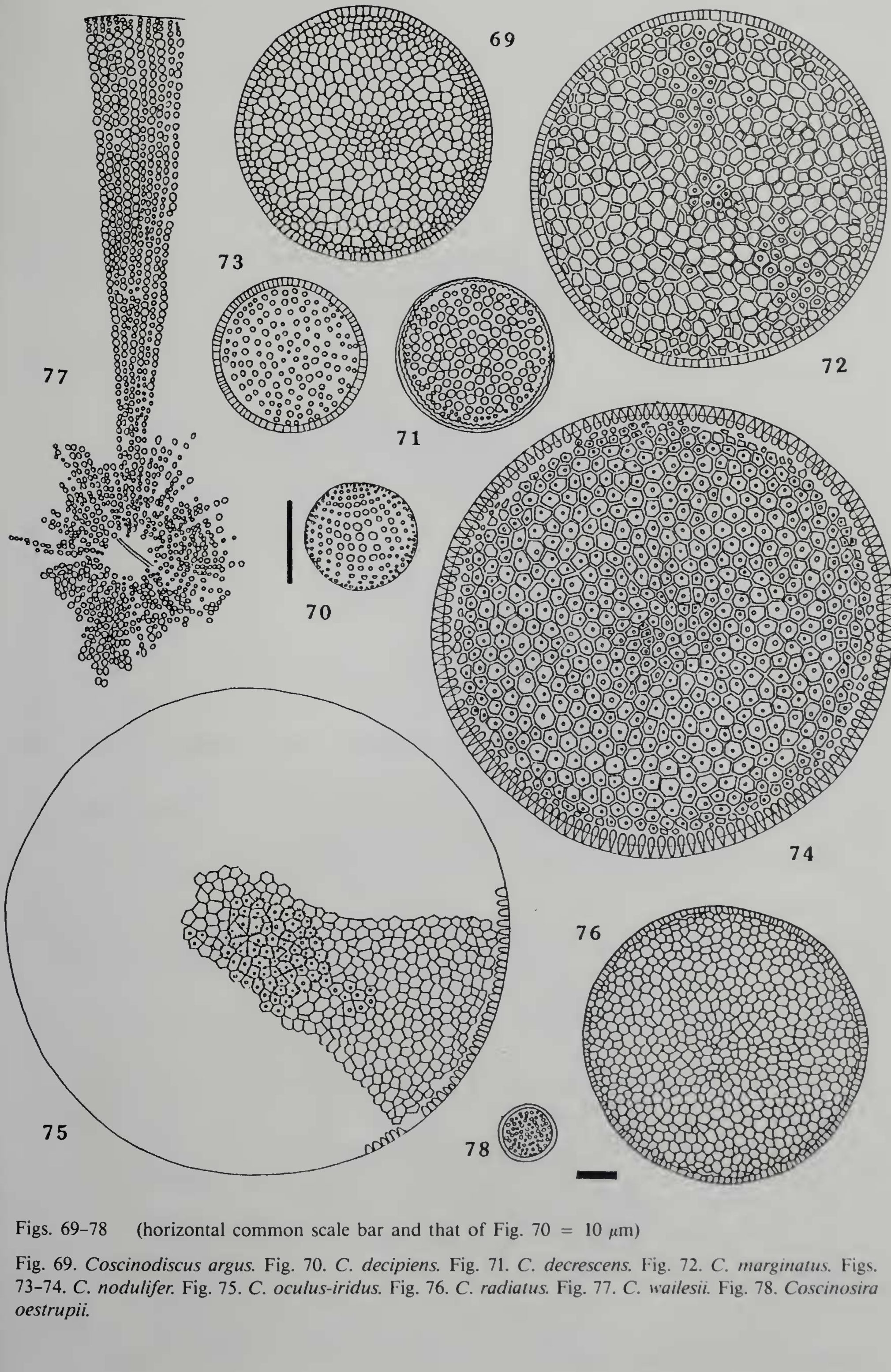
References: Cupp 1943, p. 62, fig. 26; Hendey 1964, p. 78, pl. 24, fig. 1.
Description: Diameter 100 μm, 7–8 marginal striae in 10 μm.
Distribution: Not common. Found on slide 350.
Comments: A cosmopolitan species.

C. radiatus Ehrenb. Fig. 76

References: Cupp 1943, p. 56, fig. 20; Hendey 1964, p. 76, pl. 22, fig. 7.
Description: Diameter 78–88 μm, marginal striae 10–11, areolae 2–4 in 10 μm.
Distribution: Common. Found on slides 81, 116, 333, 359.
Comments: A cosmopolitan species.

C. wailesii Gran & Angst. Fig. 77

References: Gran & Angst. 1931, p. 448, fig. 26; Cupp 1943, p. 58, fig. 23.
Description: Diameter 221 μm, 6 areolae in 10 μm.
Distribution: Rare. Found on slide 323.



Figs. 69–78 (horizontal common scale bar and that of Fig. 70 = 10 μm)

Fig. 69. *Coscinodiscus argus.* Fig. 70. *C. decipiens.* Fig. 71. *C. decrescens.* Fig. 72. *C. marginatus.* Figs. 73–74. *C. nodulifer.* Fig. 75. *C. oculus-iridus.* Fig. 76. *C. radiatus.* Fig. 77. *C. wailesii.* Fig. 78. *Coscinosira oestrupii.*

Coscinosira Gran 1900

C. oestrupii Osten. Fig. 78

References: Hendey 1964, p. 89; Simonsen 1974, p. 10, pl. 1, figs. 3–5.
Description: Diameter 13–27 μm, 4–9 areolae in 10 μm.
Distribution: Very common. Found on slides 79, 116, 333, 357.

Cyclotella (Kütz.) Bréb. 1834

C. kützingiana Thw. Fig. 79

References: Hustedt 1930, 7(1), p. 338, fig. 171; Prowse 1962, p. 7, pl. 2, fig. i, j.
Description: Diameter 11–40 μm, radial striae 7–10 in 10 μm. Freshwater.
Distribution: Very common. Found on slides 31, 33, 40, 75, 141, 257, 319.

C. menghiniana Kütz. Figs. 80–81

References: Prowse 1962, p. 7, pl. 1, fig. e, pl. 2, fig. h.
Description: Diameter 10–32 μm, 8–10 radial striae in 10 μm.
Distribution: Common. Found on slides 12, 351.
Comments: A cosmopolitan species. Freshwater to marine.

C. operculata (Ag.) Kütz. Fig. 82

References: Tiffany & Britton 1952, p. 220, fig. 6.
Description: Diameter 29 μm, 10 radial striae in 10 μm.
Distribution: Rare. Found on slide 12.
Comments: A cosmopolitan species (?). Freshwater to brackish.

C. striata (Kütz.) Grun. Figs. 83–85

References: Prowse 1962, p. 8, pl. 1, fig. f, pl. 2, figs. b, g; Gerloff & Natour 1982, p. 160, pl. 1, figs. 5, 6.
Description: Diameter 23–58 μm, radial striae 7–10 in 10 μm.
Distribution: Common. Found on slides 12, 38, 79, 357.
Comments: A cosmopolitan species. Freshwater to marine.

C. stylorum Brightw. Fig. 86

References: Hustedt 1927–66, p. 348, fig. 179; Foged 1975, p. 20, pl. 6, fig. 4.
Description: Diameter 41–87 μm, 8–10 radial and 2–4 peripheral striae in 10 μm.
Distribution: Very common. Found of slides 12, 79, 323, 355.
Comments: A cosmopolitan species.

Cymatosira Grun. 1862

C. lorenziana Grun. Fig. 87

References: Navarro 1982, p. 13, pl. 6, figs. 6–8; Foged 1984, p. 31, pl. 28, figs. 1–3, 7.
Description: Length 55 μm, breadth 15 μm, 6 striae in 10 μm. Solitary or colonial.
Distribution: Rare. Found of slide 257.
Comments: A cosmopolitan species.

Cymbella Ag. 1830

C. pusilla Grun. Fig. 88

References: Cleve 1894–95, 26(2) p. 162; Patrick & Reimer 1975. p. 25, pl. 3, fig. 18.

Description: Length 46–62 μm, breadth 8–12 μm, 18–20 dorsal, 15–16 ventral striae in 10 μm.
Distribution: Not common. Found of slide 339.
Comments: A cosmopolitan species.

Delphineis Kütz. 1844

D. surirella (Ehrenb.) G.A. Andrews (=*Rhaphoneis*). Figs. 89–90

References: Hendey 1964, p. 155, pl. 26, figs. 11–13; Andrews 1981.
Description: Length 16–26 μm, breadth 12–18 μm, 8–10 striae, 12 puncta, in 10 μm.
Distribution: Very common. Found of slides 12, 91, 259, 273, 335, 337, 343.

Denticula Kütz. 1844

D. subtilis Grun. Fig. 91

References: Patrick & Reimer 1975, p. 172, pl. 22, figs. 10–11.
Description: Length 11 μm, breadth 3 μm, 8 costae, 27–28 striae in 10 μm.
Distribution: Found of slides 12, 339.
Comments: A brackish species.

Diploneis Ehrenb. 1844

D. bombiformis Cl. Figs. 92–93

References: Cleve 1894–95, 26(2) p. 87, pl. 1, fig. 26.
Description: Length 40–42 μm, breadth 15–17 μm, 10–11 μm at the constriction, 7–8 striae in 10 μm.
Distribution: Common. Found of slides 129, 273.

D. bombus Ehrenb. Fig. 94

References: Patrick & Reimer 1966, p. 416, pl. 38, fig. 13; Hendey 1970, p. 140, pl. 5, fig. 49.
Description: Length 56–86 μm, breadth 29–34 μm, 16–24 μm at constriction, 4–5 striae in 10 μm.
Distribution: Not common. Found of slides 12, 175.
Comments: A cosmopolitan species.

D. bombus var. *densestriata* A.S. Fig. 95

References: Cleve 1894–95, 26(2) p. 90.
Description: Length 50 μm, breadth 21 μm, 12 μm at constriction, 7 striae in 10 μm.
Distribution: Rare. Found of slide 12.

D. chersonensis (Grun.) Cl. Fig. 96

References: Cleve 1894–95, 26(2) p. 91; Hendey 1970, p. 142, pl. 5, fig. 48.
Description: Length 65–76 μm, breadth 27–32 μm, 16–18 μm at constriction, 5–7 striae in 10 μm.
Distribution: Rare. Found on slides 93, 124.
Comments: A cosmopolitan species. According to Podzorski & Håkansson (1987), this species is widespread in all seas, with the larger specimens limited to tropical waters.

D. coffaeiformis A.S. Fig. 97

References: Cleve 1894–95, 26(2) p. 81.
Description: Length 22–48 μm, breadth 11–24 μm, 8–12 striae in 10 μm.
Distribution: Very common. Found on slides 335, 341, 343, 347.

D. crabro Ehrenb. Fig. 98

References: Cleve 1894–95, 26(2) p. 100; Hendey 1970, p. 141, pl. 3, fig. 29.
Description: Length 69–82 μm, breadth 26–32 μm, 15–24 μm at constriction, 4–5 striae in 10 μm.
Distribution: Very common. Found on slides 48, 315, 335, 345, 350.
Comments: Common in tropical coastal waters.

D. exemta var. *digrediens* Cl. Fig. 99

References: Cleve 1894–95, 26(2) p. 86.
Description: Length 48–64 μm, breadth 18–20 μm, 10–11 μm at constriction, 7–9 striae in 10 μm.
Distribution: Common. Found on slides 125, 175, 335, 341.

D. gravelleana Hagelst. Fig. 100

References: Navarro 1982, p. 34, pl. 22, figs. 6–8; Foged 1984, p. 36, pl. 41, fig. 2.
Description: Length 19–30 μm, breadth 9–10 μm, 4–5 μm at constriction, 13–15 striae in 10 μm.
Distribution: Common. Found on slides 175, 335, 339.

D. incurvata (Greg.) Cl. Fig. 101

References: Cleve 1894–95, 26(2) p. 84.
Description: Length 58–71 μm, breadth 17 μm, 10 μm at constriction, 10–11 striae in 10 μm.
Distribution: Common. Found on slides 37, 91, 341, 351.
Comments: A cosmopolitan species (?).

D. interrupta (Kütz.) Cl. Figs. 102–103

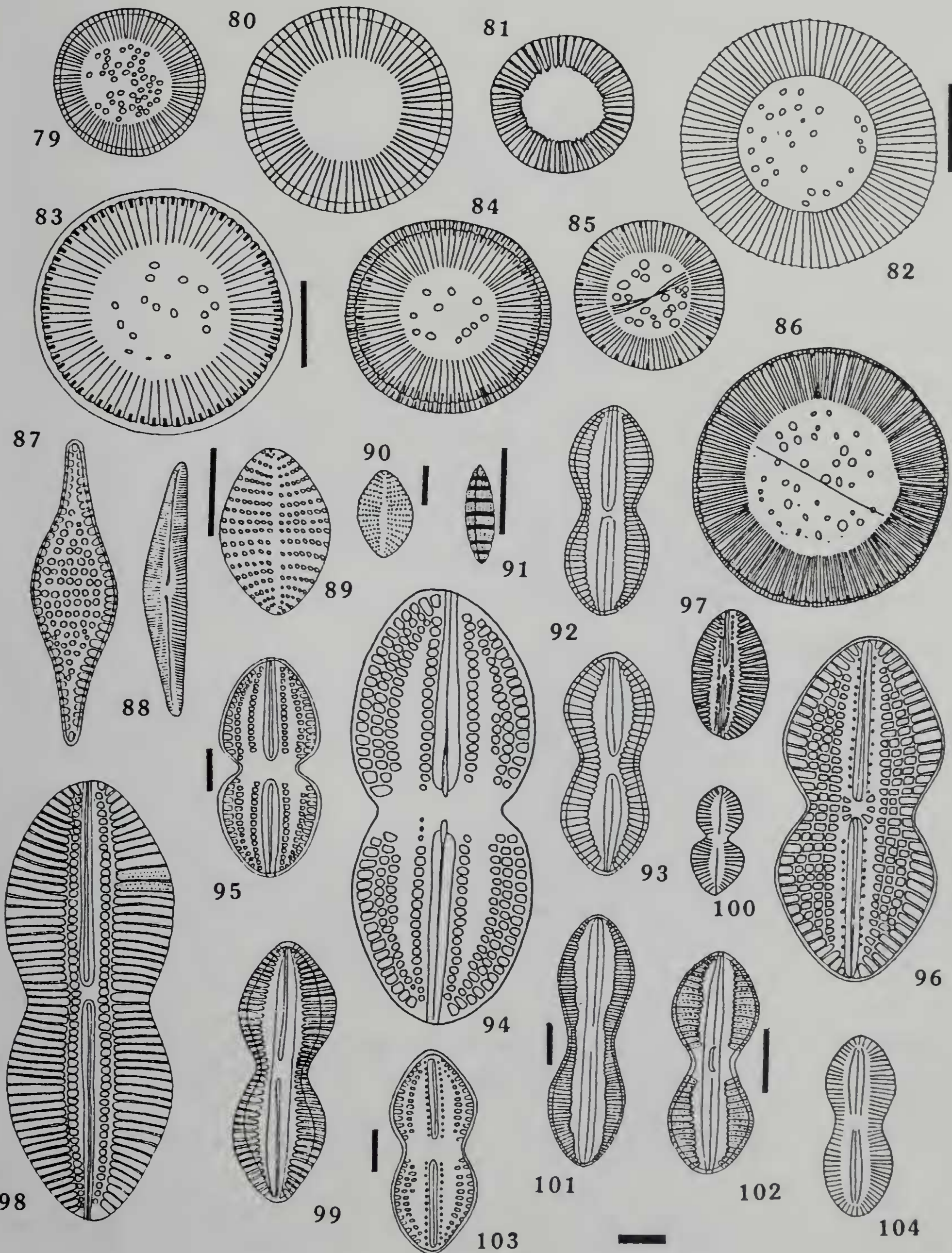
References: Cleve 1894–95, 26(2) p. 84; Prowse 1962, p. 34, pl. 9, fig. k.
Description: Length 27–80 μm, breadth 10–24 μm, 7–13 μm at constriction, 7–8 striae in 10 μm.
Distribution: Rare. Found on slide 12.
Comments: A cosmopolitan species. Freshwater to marine.

D. interrupta var. *gorjanovicii* Pant. Fig. 104

References: Cleve 1894–95, 26(2) p. 84.
Description: Length 24–42 μm, breadth 12–17 μm, 7–11 μm at the constriction, 8–13 striae in 10 μm.
Distribution: Very common. Found on slides 125, 259, 347.
Comments: Brackish to marine.

D. litoralis (Donk.) Cl. Figs. 105–106

References: Cleve-Euler 1953, 4(5), p. 80, fig. 649; Hendey 1964, p. 226, pl. 32, fig 9.
Description: Length 35–36 μm, breadth 17–18 μm, 11–14 striae in 10 μm.



Figs. 79–104 (horizontal common scale bar and those of Figs. 82, 83, 89–91, 95, 101–103 = 10 μm)

Fig. 79. *Cyclotella kützingiana.* Figs. 80–81. *C. menghiniana.* Fig. 82. *C. operculata.* Figs. 83–85. *C. striata.* Fig. 86. *C. stylorum.* Fig. 87. Cymatosira lorenziana. Fig. 88. *Cymbella pusilla.* Figs. 89–90. *Delphineis surirella.* Fig. 91. *Denticula subtilis.* Fig. 92–93. *Diploneis bombiformis.* Fig. 94. *D. bombus.* Fig. 95. *D. bombus* var. *densestriata.* Fig. 96. *D. chersonensis.* Fig. 97. *D. coffaeiformis.* Fig. 98. *D. crabro.* Fig. 99. *D. exemta* var. *digrediens.* Fig. 100. *D. gravelleana.* Fig. 101. *D. incurvata.* Figs. 102–103. *D. interrupta.* Fig. 104. *D. interrupta* var. *gorjanovicii.*

Distribution: Common. Found on slide 12.
Comments: A cosmopolitan species.

D. nitescens (Greg.) Cl. Fig. 107

References: Hustudt 1959, 7(2), p. 640, fig. 1047; Cleve-Euler 1953, 4(5), p. 85, fig. 658.
Description: Length 48–54 μm, breadth 28–33 μm, 5–6 costae in 10 μm.
Distribution: Not common. Found on slides 120, 343.
Comments: A cosmopolitan species.

D. notabilis (Grev.) Cl. Fig. 108

References: Hendey 1964, p. 224, pl. 32, fig. 11.
Description: Length 54 μm, breadth 42 μm, 5–6 costae in 10 μm.
Distribution: Rare. Found on slide 119.
Comments: A cosmopolitan species (?). Freshwater.

D. oculata (Bréb.) Cl. Fig. 109

References: Patrick & Reimer 1966, p. 412, pl. 38, fig. 6.
Description: Length 17–18 μm, breadth 7–9 μm, 20–22 striae in 10 μm.
Distribution: Not common. Found on slide 343.
Comments: A cosmopolitan species. Freshwater.

D. puella (Schum.) Cl. Fig. 110

References: Cleve 1894–95, 26(2) p. 92; Patrick & Reimer 1966, p. 414, pl. 38, fig. 9.
Description: Length 27–34 μm, breadth 11–17 μm, 10–13 striae in 10 μm.
Distribution: Common. Found on slides 91, 350.

D. smithii (Bréb.) Cl. Figs. 111–112

References: Cleve 1894–95, 26(2) p. 96; Patrick & Reimer 1966, p. 410, pl. 38, fig. 2.
Description: Length 48–76 μm, breadth 22–36 μm, 5–9 costae in 10 μm.
Distribution: Not common. Found on slides 12, 93, 130, 175, 337, 345, 359.
Comments: A cosmopolitan species. Freshwater to marine.

D. smithii var. *rhombica* Meresch. Fig. 113

References: Hendey 1964, p. 225; Kaczmarska & Rushforth 1983, p. 20, pl. 17, fig. 1.
Description: Length 53 μm, breadth 23 μm, 9 to 11 costae in 10 μm towards poles.
Distribution: Rare. Found on slide 37.
Comments: A cosmopolitan species.

D. subovalis Cl. Fig. 114

References: Cleve 1894–95, 26(2) p. 96, pl. 1, fig. 27; Foged 1979, p. 45, pl. 21, figs. 5, 6 & 11.
Description: Length 31–49 μm, breadth 18–26 μm, 8–9 costae in 10 μm.
Distribution: Not common. Found on slides 125, 355, 357.
Comments: A cosmopolitan species. Freshwater to marine.

D. vetula Cl. Fig. 115

References: Cleve 1894–95, 26(2) p. 85; Hendey 1964, p. 224, fig. 6.
Description: Length 33 μm, breadth 12 μm, 10 μm at constriction, 10 costae in 10 μm.

Distribution: Not common. Found of slides 259, 341.
Comments: Podzorski & Hakânsson (1987) report its presence in Palawan, although they state that it is common in the European coastal waters.

D. weissflogii (A.S.) Cl. Figs. 116–117

References: Cleve 1894–95, 26(2) p. 91; Hustedt 1959, 7(2), p. 703, fig. 1085.
Description: Length 29–74 μm, breadth 11–24 μm, 7–12 μm at constriction, 6–9 costae in 10 μm.
Distribution: Common. Found of slides 335, 350, 359.
Comments: A cosmopolitan species.

Donkinia Ralfs 1888

D. recta (Donk.) Grun. Fig. 118

References: Cleve 1965, 26(2) p. 119; Hendey 1964, p. 251, pl. 35, fig. 7.
Description: Length 108–312 μm, breadth 22–38 μm, 18–20 striae in 10 μm.
Distribution: Rare. Found of slides 79, 93.
Comments: A cosmopolitan species.

Eunotogramma Weisse 1854

E. laeve Grun. Figs. 119–120

References: Foged 1979, p. 52, pl. 6, fig. 2.
Description: Length 25–35 μm, breadth 6–8 μm, 2–3 septa in 10 μm.
Distribution: Not common. Found on slides 120, 132.

Fragilaria Lyng. 1819

F. cylindrus Grun. Figs. 121–122

References: Cleve-Euler 1953, 4(1), p. 51, fig. 363a–k; Hendey 1964, p. 153.
Description: Length 29–38 μm, breadth 5–6 μm, 8–12 striae in 10 μm. Colonial, united into ribbons; attached by mucilage stalk; rare.
Distribution: Common in the Arctic seas. Found on slide 12.

F. lapponica Grun. Fig. 123

References: Hustedt 1959, 7(2), p. 170, fig. 678; Patrick & Reimer 1966, p. 130, pl. 4, fig. 17.
Description: Length 38–66 μm, breadth 4–6 μm, 7–10 striae in 10 μm. Colonial, united into ribbons.
Distribution: Common. Found on slides 75, 273, 357.
Comments: Freshwater to marine.

F. leptostauron var. *dubia* (Grun.) Hust. Fig. 124

References: Cleve-Euler 1953, 4(1), p. 36, fig. 347p–u; Patrick & Reimer 1966, p. 124, pl. 4, fig. 3.
Description: Length 20 μm, breadth 6 μm, 5 costae in 10 μm. Colonial, united into straight to zigzag filamentous chains.
Distribution: Rare. Found on slide 48.
Comments: A cosmopolitan species.

F. oceanica Cl. Fig. 125

References: Cleve-Euler 1953, 4(1), p. 52, fig. 365, Hendey 1964, p. 153.
Description: Length 37 μm, breadth 5 μm, 11 costae in 10 μm. Colonial, united to form ribbon-like chains.
Distribution: Rare. Found on slide 12.
Comments: Common in the Arctic seas.

F. schulzi Brockmann. Fig. 126

References: Hendey 1964, p.154, pl. 26, fig. 16.
Description: Length 25 μm, breadth 5 μm, 13 striae in 10 μm.
Distribution: Rare. Found on slide 257.

Grammatophora Ehrenb. 1839

G. hamulifera Kütz. Figs. 127–128

References: Hendey 1964, p. 171.
Description: Length 17 μm, breadth at girdle 13 μm, 18 striae in 10 μm. Colonial.
Distribution: Very common. Found on slides 93, 337, 343, 347.
Comments: A cosmopolitan species.

G. marina var. *adriatica* Grun. Fig. 129

References: Cupp 1943, p. 174, fig. 125B.
Description: Length 73–80 μm, breadth at valve 5–7 μm and girdle 17–21 μm, 25–30 striae in 10 μm. Colonial, joined into zig-zag chains.
Distribution: Very common. Found on slides 1, 79, 273, 335, 339, 359.
Comments: A cosmopolitan species.

G. oceanica Ehrenb. Figs. 130–131

References: Cupp 1943, p. 176, fig. 126; Hendey 1964, p. 170.
Description: Length 25–48 μm, breadth 5–7 μm, 22–24 striae in 10 μm. Colonial.
Distribution: Common. Found on slides 1, 116, 345.
Comments: A cosmopolitan species.

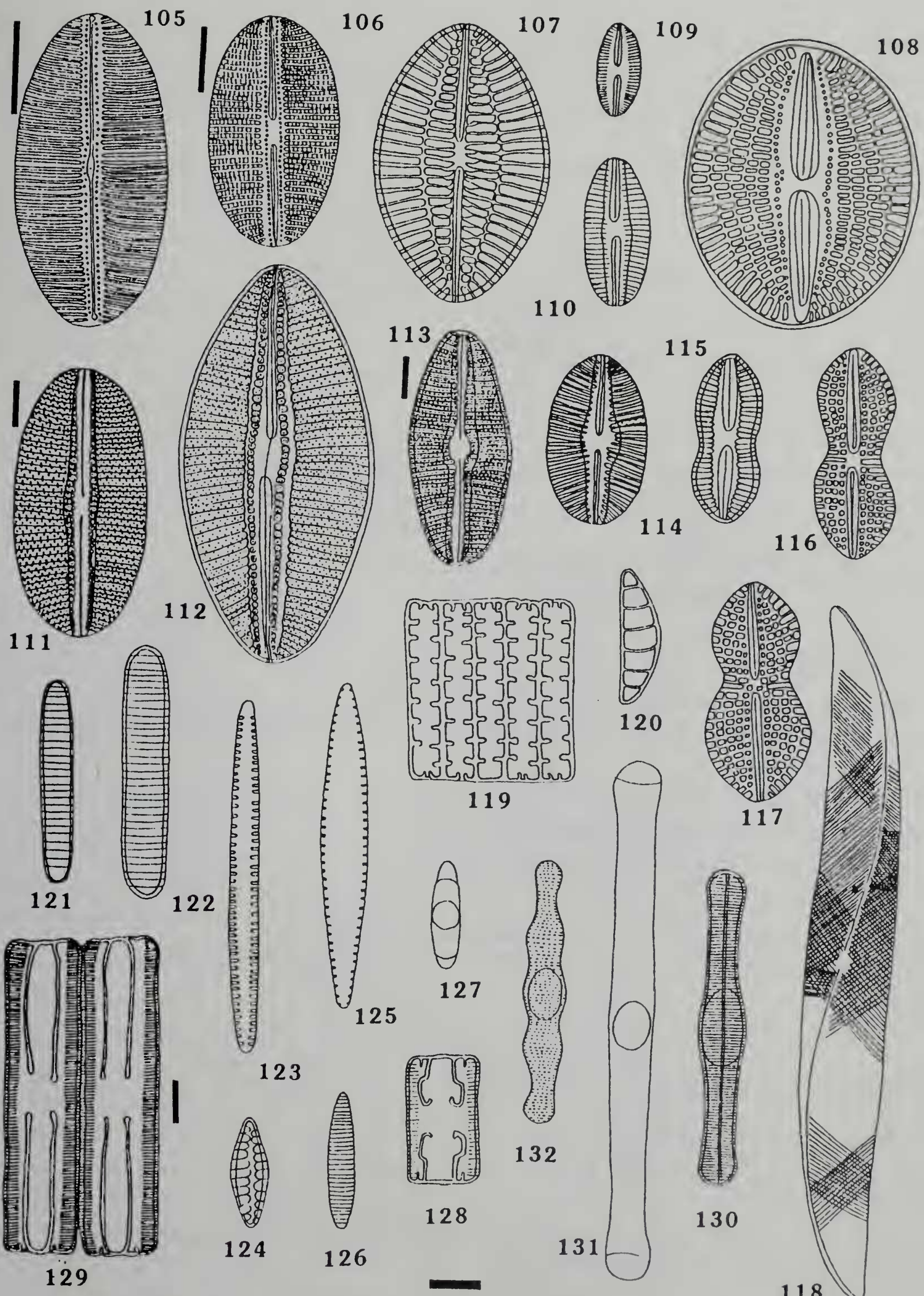
G. undulata Ehrenb. Fig. 132

References: Boyer 1926–27, p. 156; Foged 1984, p. 45, pl. 24, fig. 4.
Description: Length 40–48 μm, breadth 7–8 μm, 20–21 striae in 10 μm. Colonial.
Distribution: Rare. Found on slides 333, 337.
Comments: A cosmopolitan species.

Gyrosigma Hassall 1845

G. balticum (Ehrenb.) Rabh. Figs. 133–134

References: Hendey 1964, p. 248, pl. 35, fig. 9; Patrick & Reimer 1966, p. 324, pl. 25, fig. 1.
Description: Length 280–332 μm, breadth 28–30 μm, 11–12 transverse/longitudinal striae in 10 μm. Occurring in large colonies.
Distribution: Rare. Found on slide 95.
Comments: A cosmopolitan species.



Figs. 105-132 (horizontal common scale bar and those of Figs. 105, 106, 111, 113 and 129 = 10 μm)

Figs. 105-106. *Diploneis littoralis.* Fig. 107. *D. nitescens.* Fig. 108. *D. notabilis.* Fig. 109. *D. oculata.* Fig. 110. *D. puella.* Figs. 111-112. *D. smithii.* Fig. 113. *D. smithii* var. *rhombica.* Fig. 114. *D. subovalis.* Fig. 115. *D. vetula.* Figs. 116-117. *D. weissflogi.* Fig. 118. *Donkinia recta.* Figs. 119-120. *Eunotogramma laeve,* girdle and valve view. Figs. 121-122. *Fragilaria cylindrus.* Fig. 123. *F. lapponica.* Fig. 124. *F. leptostauron* var. *dubia.* Fig. 125. *F. oceanica.* Fig. 126. *F. schulzi.* Figs. 127-128. *Grammatophora hamulifera,* valve view and girdle view. Fig. 129. *G. marina* var. *adriatica,* two cells in girdle view. Figs. 130-131. *G. oceanica.* Fig. 132. *G. undulata.*

G. distortum (W. Sm.) Griff & Henfr. Fig. 135

References: Cleve 1894–95, 26(2) p. 116; Patrick & Reimer 1966, p. 324, pl. 24, fig. 6.
Description: Length 32 μm, breadth 9 μm, 23–24 transverse, 25–26 longitudinal striae in 10 μm. Solitary or colonial.
Distribution: Rare. Found on slide 12.

G. exile (Grun.) Reim. Fig. 136

References: Patrick & Reimer 1966, p. 322, pl. 24, fig. 4.
Description: Length 46 μm, breadth 8 μm, 25–28 transverse, 30–32 longitudinal striae in 10 μm. Rare. Freshwater to brackish.
Distribution: Found on slide 12.

G. fasciola var. *sulcata* (Grun.) Cl. Fig. 137

References: Hendey 1964, p. 249; Patrick & Reimer 1966, p. 328, pl.26, fig. 4.
Description: Length 52 μm, breadth 9 μm, 20 transverse, 17 longitudinal striae in 10 μm. Solitary or colonial.
Distribution: Rare. Found on slides 12, 351, 353.
Comments: A cosmopolitan species.

G. grovei Cl. Fig. 138

References: Cleve 1894–95, 26(2) p. 118.
Description: Length 163–351 μm, breadth 23–28 μm, 9–10 transverse, 12 longitudinal striae in 10 μm.
Distribution: Rare. Found on slides 19, 95, 353, 357.
Comments: Brackish to marine.

G. simile (Grun.) Boyer. Fig. 139

References: Hustedt 1955, p. 34, pl. 10, fig. 3.
Description: Length 54–71 μm, breadth 8–13 μm, 15 transverse, 16 longitudinal striae in 10 μm.
Distribution: Common. Found on slides 125, 357, 359.

Hantzschia Grun. 1880

H. amphioxys var. *capitata* O. Müll. Fig. 140

References: Tiffany & Britten 1952, p. 289, pl. 75, fig. 887; Prowse 1962, p. 64, pl. 19, fig. t.
Description: Length 58–80 μm, breadth 10 μm, 16–24 striae, 5–7 fibulae in 10 μm.
Distribution: Rare. Found on slide 31.
Comments: A cosmopolitan species. Freshwater to marine.

H. virgata (Roper) Grun. Fig. 141

References: Hendey 1964, p. 285, pl. 39, fig. 1; Foged 1979, p. 63, pl. 40, fig. 10.
Description: Length 102 μm, breadth 10 μm, 14 striae, 5–6 fibulae in 10 μm.
Distribution: Rare. Found on slide 38.
Comments: A cosmopolitan and common littoral species of clean, sandy shores (Hendey, 1964).

Huttoniella Karsten 1928

H. reichardtii (Grun.) Hust. Fig. 142

References: Hendey 1964, p. 114 (as *Huttonia reichardtii* Grun.); Foged 1984, p. 47, pl. 25, fig. 6.
Description: Length 20 μm, breadth 15 μm.
Distribution: Rare. Found on slide 91.

Isthmia Ag. 1827

I. enervis Ehrenb. Fig. 143

References: Boyer 1926–27, p. 140; Hendey 1964, p. 110, pl. 25, fig. 2.
Description: Length 200 μm, breadth 32 μm in girdle view, 3–4 areolae in 10 μm. United into short chain.
Distribution: Common. Found on slides 1, 3, 116.
Comments: A cosmopolitan species.

Licmophora Ag. 1827

L. abbreviata Ag. Figs. 144–145

References: Hendey 1964, p. 167.
Description: Length 55–64 μm, 8–13 μm at broadest part, 10–16 striae in 10 μm. Solitary or colonial.
Distribution: Common. Found on slides 1,3, 116, 337.
Comments: A cosmopolitan species.

L. ehrenbergii (Kütz.) Grun. Figs. 146–148

References: Hustedt 1959, 7(2), p. 70, fig. 593; Hendey 1964, p. 168.
Description: Length 60–101 μm, 12–14 at the broadest part, 8–12 (middle), 12–14 (upper end) striae in 10 μm. Colonial.
Distribution: Common. Found on slides 1, 91, 333.
Comments: A cosmopolitan species.

L. flabellata (Carm.) Ag. Figs. 149–150

References: Hendey 1964, p. 168, pl. 26, fig. 5; Foged 1975, p. 27, pl. 10, fig. 7.
Description: Length 77 μm, breadth 15 μm (girdle), 6 μm (valve). In fan-shaped colonies.
Distribution: Not common. Found on slide 347.
Comments: A cosmopolitan species.

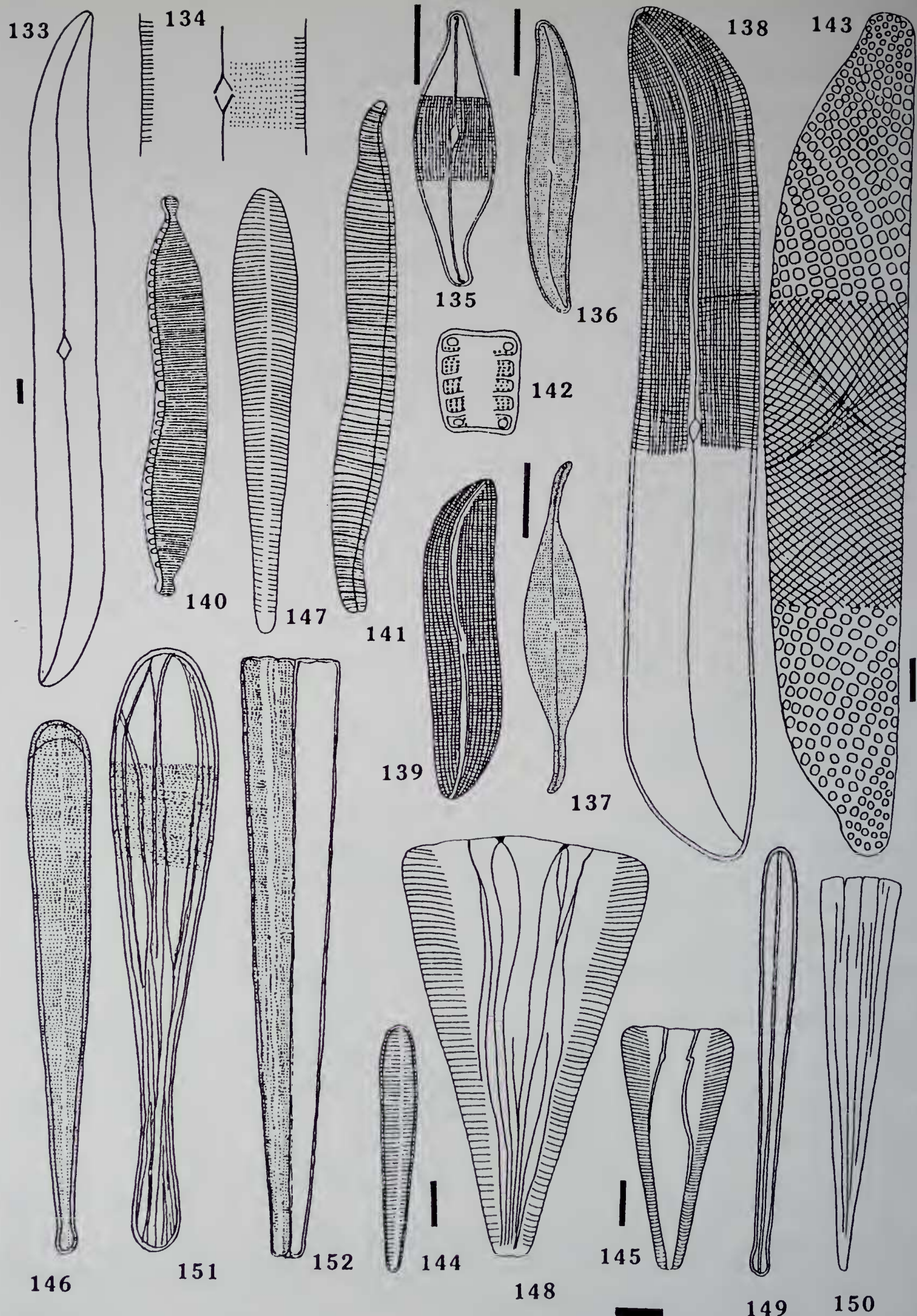
L. gracilis (Ehrenb.) Grun. Figs. 151–152

References: Boyer 1926–27, p. 167; Hendey 1964, p. 167.
Description: Length 144 μm, breadth 24 μm (valve), 20 striae in 10 μm. In fan-shaped colonies, attached by a mucous stipe.
Distribution: Rare. Found on slide 116.
Comments: A cosmopolitan species.

Mastogloia Thwaites 1856

M. angulata Lewis Fig. 153

References: Cleve 1894–95, 27(3), p. 147; Foged 1975, p. 28, pl. 12, fig. 2, pl. 13, figs. 1, 2.



Figs. 133–152 (horizontal common scale bar and those of Figs. 133, 135–137, 143, 144 and 145 = 10 μm)

Figs. 133–134. *Gyrosigma balticum*, valve view and details of striations. Fig. 135. *G. distortum*. Fig. 136. *G. exile*. Fig. 137. *G. fasciola* var. *sulcata*. Fig. 138. *G. grovei*. Fig. 139. *G. simile*. Fig. 140. *Hantzschia amphioxys* var. *capitata*. Fig. 141. *H. virgata*. Fig. 142. *Huttoniella reichardtii*, girdle view. Fig. 143. *Isthmia enervis*, girdle view. Figs. 144–145. *Licmophora abbreviata*, valve view and girdle view. Figs. 146–148. *L. ehrenbergii*, valve views and girdle view. Figs. 149–150. *L. flabellata*, valve view and girdle view. Figs. 151–152. *L. gracilis*, valve view and girdle view.

Description: Length 55–76 μm, breadth 28–34 μm, 8–10 striae, 1 loculi in 10 μm.
Distribution: Not common. Found on slides 125, 341.
Comments: A cosmopolitan species.

M. binotata (Grun.) Cl. Fig. 154

References: Hendey 1964, pl. 37, fig. 11; Foged 1975, p. 29, pl. 12, figs. 6–9.
Description: Length 21–36 μm, breadth 15–23 μm, 12–13 striae, 11 puncta in 10 μm.
Distribution: Not common. Found on slides 93, 341, 343, 347.
Comments: Common in warm coastal and temperate waters.

M. citrus Cl. Figs. 155–156

References: Cleve 1894–95, 27(3), p. 157, pl. 2, fig. 6.
Description: Length 46 μm, breadth 21 μm, 18 middle and 22 polar striae, 7–8 loculi in 10 μm.
Distribution: Common. Found on slides 124, 335, 337, 345, 350.
Comments: Common in tropical seas.

M. fimbriata (Brightw.) Cl. Fig. 157

References: Hendey 1970, p.146, pl. 1, fig. 11; Gerloff & Natour 1982, p. 184.
Description: Length 47–63 μm, breadth 34–54 μm, 6–8 striae, 4–6 loculi in 10 μm.
Distribution: Very common. Found on slides 2, 124, 335, 343, 345, 347.
Comments: A cosmopolitan species.

M. ovata Grun. Fig. 158

References: Cleve 1894–95, 27(3), p. 156.
Description: Length 43 μm, breadth 32 μm, 15–16 striae, 3–4 loculi in 10 μm.
Distribution: Common. Found on slide 333.
Comments: Common in warm coastal waters.

M. quinquecostata Grun. Fig. 159

References: Cleve 1894–95, 27(3), p. 161; Foged 1975, p. 33, pl. 15, figs. 7, 8.
Description: Length 38–56 μm, breadth 18 μm, 16 striae, 2–3 loculi in 10 μm.
Distribution: Not common. Found on slides 91, 341, 345.

Melosira Ag. 1824

M. granulata (Ehrenb.) Ralfs. Figs. 160–161

References: Prowse 1962, p. 6, pl. 1, figs. a–b.
Description: Length 10–22 μm, diameter 10–11 μm, 8–9 striae in 10 μm.
Distribution: Not common. Found on slide 175.
Comments: A cosmopolitan species. Freshwater to marine.

M. nummuloides (Dillw.) Ag. Fig. 162

References: Cleve-Euler 1951, 2(1), p. 32, figs. 28a–d.; Hendey 1964, p. 72.
Description: Diameter 22–40 μm.
Distribution: Very common. Found on slides 3, 79, 116, 175, 257, 339, 343, 359.
Comments: A cosmopolitan species.

Navicula Bory 1824

N. brasiliensis Grun. Fig. 163

References: Cleve-Euler 1953, 4(5), p.110, fig. 718; Hendey 1970, p. 133, pl. 4, fig. 40.
Description: Length 52–98 μm, breadth 29–40 μm, 8–10 striae in 10 μm, 9–10 punctae in 10 μm.
Distribution: Very common. Found on slides 37, 91, 175, 333, 357.

N. clavata Greg. Fig. 164

References: Cleve 1894–95, 27(3), p. 61; Hustedt 1927–66, p. 3–444, fig. 1509 a–c; Gerloff & Natour 1982, p. 187, pl. 14, fig. 1.
Description: Length 56–88 μm, breadth 30–38 μm, 9–12 striae in 10 μm, 8–10 punctae in 10 μm.
Distribution: Common. Found on slides 12, 91, 93, 119.

N. cuspidata Kütz. Fig. 165

References: Cleve 1894–95, 26(2) p. 109.
Description: Length 61 μm, breadth 14 μm, 13 transverse, 25 longitudinal striae in 10 μm.
Distribution: Rare. Found on slide 350.
Comments: A cosmopolitan species. Freshwater to marine.

N. distans W. Sm. Fig. 166

References: Cleve 1965, 27(3), p. 35; Hendey 1964, p. 203, pl. 27, fig. 13.
Description: Length 94 μm, breadth 17 μm, 4 striae, 21 lineolae in 10 μm.
Distribution: Rare. Found on slide 12.

N. forcipata var. *suborbicularis* Grun. Fig. 167

References: Cleve 1894–95, 27(3), p. 66.
Description: Length 23 μm, breadth 14 μm, 15 striae in 10 μm.
Distribution: Rare. Found on slide 273.
Comments: A cosmopolitan species.

N. glacialis Cl. Fig. 168

References: Cleve 1894–95, 27(3), p. 40; Cleve-Euler 1953, 4(5), p. 110, fig. 719.
Description: Length 84–98 μm, breadth 36–50 μm, 9–12 striae, 6–9 puncta in 10 μm.
Distribution: Not common. Found on slides 93, 119.
Comments: A cosmopolitan species.

N. grundleri Cl. Fig. 169

References: Cleve 1878, p.7, pl. 2, fig. 10; Cleve 1894–95, 27(3), p. 51.
Description: Length 50–51 μm, breadth 12–13 μm, 10 striae, 11 puncta in 10 μm.
Distribution: Common. Found on slides 12, 278, 337.

N. halophila (Grun.) Cl. Figs. 170–171

References: Cleve 1894–95, 26(2) p. 109; Patrick & Reimer 1966, p. 467, pl. 44, fig. 4.
Description: Length 38–54 μm, breadth 10–11 μm, 15–25 striae in 10 μm.
Distribution: Not common. Found on slides 12, 278.
Comments: A cosmopolitan species. Freshwater.

N. lyra Ehrenb. Fig. 172

References: Hendey 1964, p. 209, pl. 33, fig. 2; Patrick & Reimer 1966, p. 443, pl. 39, figs. 5–6.
Description: Length 92–144 μm, breadth 39–61 μm, 9–10 striae, 8–11 puncta in 10 μm.
Distribution: Common. Found on slide 125.
Comments: A cosmopolitan species.

N. menaiana Hend. Fig. 173

References: Hendey 1964, p. 207, pl. 31, fig. 13.
Description: Length 52 μm, breadth 20 μm, 10 striae in 10 μm.
Distribution: Common. Found on slide 38, 353.

N. monilifera Cl. Fig. 174

References: Hustedt 1961–66, 7(3), p. 711, fig. 1699a; Hendey 1964, p. 206, pl. 31, figs. 4–5.
Description: Length 50–83 μm, breadth 26–44 μm, 9–10 striae in 10 μm.
Distribution: Very common. Found on slides 37, 93, 124, 138.
Comments: A cosmopolitan species (?).

N. monilifera var. *constricta* (Perag.) Hust. Fig. 175

References: Cleve 1894–95, 27(3), p. 43; Hustedt 1961–66, 7(3), p. 712, fig. 1699b.
Description: Length 95–101 μm, breadth 49–50 μm, 7–8 striae, 6–8 puncta in 10 μm.
Distribution: Common. Found on slides 2, 38, 122.
Comments: This is a littoral species of the mediterranean and northern Europe (Podzorski & Håkansson, 1987).

N. nicaeensis Perag. Fig. 176

References: Cleve 1894–95, 27(3), p. 36.
Description: Length 63 μm, breadth 15 μm, 8 striae in 10 μm.
Distribution: Rare. Found on slide 12.

N. pennata A. Sch. Fig. 177

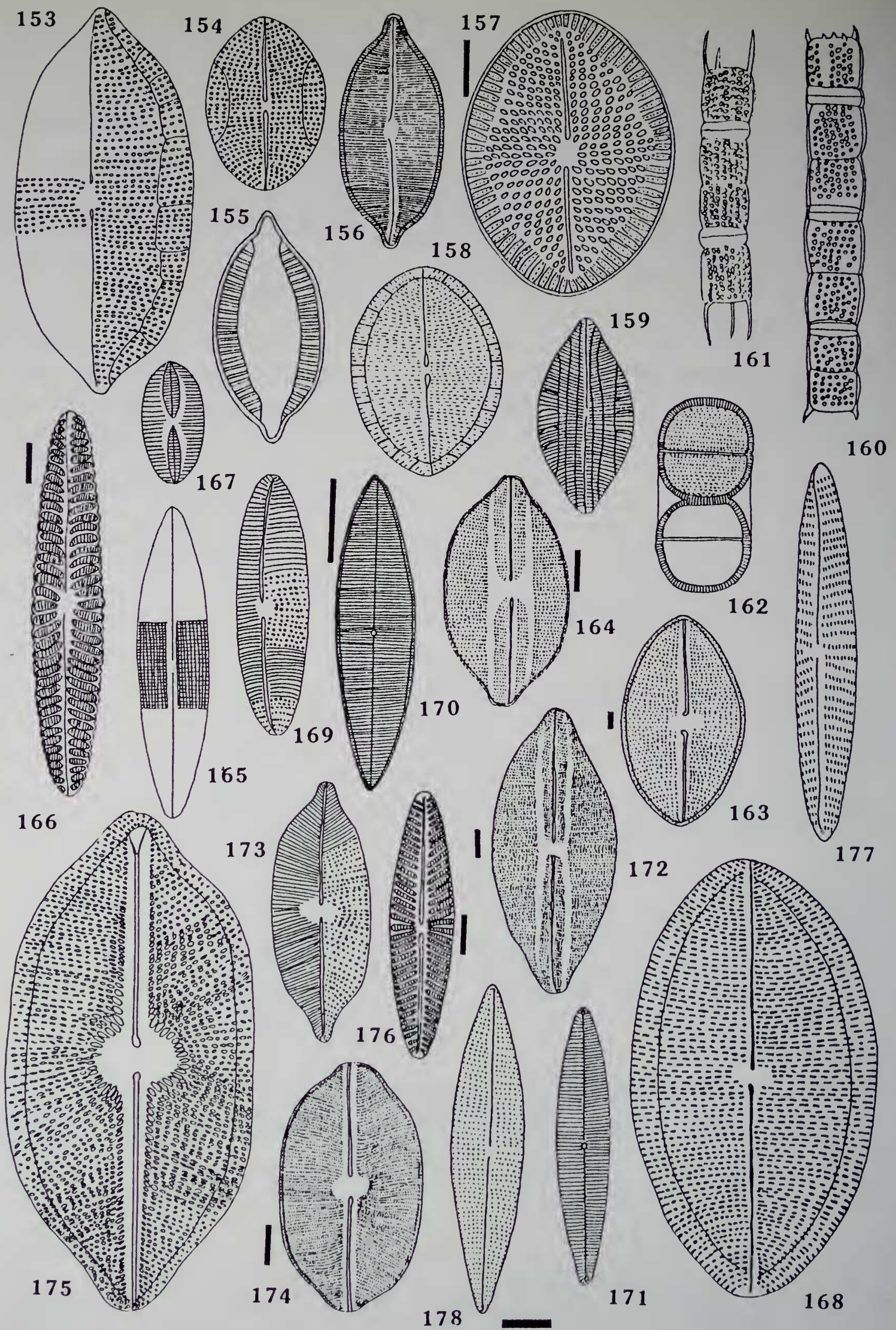
References: Cleve 1894–95, 27(3), p. 32; Hendey 1964, p. 203, pl. 30, fig. 21.
Description: Length 54–74 μm, breadth 9–12 μm, 5–7 middle and 6–8 polar striae in 10 μm.
Distribution: Found on slide 125.

N. pi Cl. Fig. 178

References: Cleve 1894–95, 27(3), p. 50.
Description: Length 64 μm, breadth 14 μm, 11 middle and 12 polar striae, 12 puncta in 10 μm.
Distribution: Rare. Found on slide 81.

N. platessa Cl. Fig. 179–180

References: Cleve 1894–95, 27(3), p. 36.
Description: Length 25–43 μm, breadth 13–21 μm, 5–9 striae in 10 μm.
Distribution: Very common. Found on slides 12, 38, 175, 259, 343, 350, 359.



Figs. 153–178 (horizontal common scale bar and those of Figs. 157, 163, 164, 166, 170, 172, 174 and 176 = 10 μm)

Fig. 153. *Mastogloia angulata*, internal valve view showing loculi. Fig. 154. *M. binotata*, internal valve view showing loculi. Figs. 155–156. *M. citrus*, internal valve view showing loculi and external valve view. Fig. 157. *M. fimbriata*, internal valve view showing loculi. Fig. 158. *M. ovata*, internal valve view showing loculi. Fig. 159. *M. quinquecostata*, internal valve view showing loculi. Figs. 160–161. *Melosira granulata*, cells showing colony formation. Fig. 162. *M. nummuloides*, cells showing colony formation. Fig. 163. *Navicula brasiliensis.* Fig. 164. *N. clavata.* Fig. 165. *N. cuspidata.* Fig. 166. *N. distans.* Fig. 167. *N. forcipata* var. *suborbicularis.* Fig. 168. *N. glaciàlis.* Fig. 169. *N. grundleri.* Figs. 170–171. *N. halophila.* Fig. 172. *N. lyra.* Fig. 173. *N. menaiana.* Fig. 174. *N. monilifera.* Fig. 175. *N. monilifera* var. *constricta.* Fig. 176. *N. nicaeensis.* Fig. 177. *N. pennata.* Fig. 178. *N. pi.*

N. platyventris Meist. Fig. 181

References: Foged 1975, p. 41, pl. 20, fig. 17.
Description: Length 16 μm, breadth 7 μm, 9 striae in 10 μm.
Distribution: Rare. Found on slide 125.

N. plicata Donk. Fig. 182

References: Hustedt 1961–66, 7(3), p. 328, fig. 1443; Hendey 1964, p. 193.
Description: Length 74 μm, breadth 17 μm, 19 middle and 20–21 polar striae in 10 μm.
Distribution: Rare. Found on slide 116.

N. praetexta Ehrenb. Fig. 183

References: Cleve 1894–95, 27(3), p. 55; Hendey 1964, p. 213, pl. 33. fig. 1.
Description: Length 48 μm, breadth 26 μm, 8 striae in 10 μm.
Distribution: Rare. Found on slide 33.
Comments: A cosmopolitan species.

N. pusilla var. *jamalinensis* Grun. Fig. 184

References: Cleve 1894–95, 27(3), p. 41; Patrick & Reimer 1966, p. 453, pl. 41, fig. 8.
Description: Length 50–56 μm, breadth 20–23 μm, 10–12 middle, 14–16 pole striae, 12 punctae in 10 μm.
Distribution: Not common. Found on slide 175.
Comments: A cosmopolitan species. Freshwater to marine.

N. radiosa Kütz. Fig. 185

References: Cleve 1894–95, 27(3), p. 17; Caljon 1983, p. 133, pl. 26, fig. 23.
Description: Length 42–55 μm, breadth 8–9 μm, 10–12 striae in 10 μm.
Distribution: Not common. Found on slide 339.
Comments: A cosmopolitan species. Freshwater to marine.

N. ramosissima (Ag.) Cl. Fig. 186

References: Cleve 1894–95, 27(3), p. 26; Hendey 1964, p. 194, pl. 30, fig. 9.
Description: Length 46–59 μm, breadth 10–12 μm, 11 striae in 10 μm.
Distribution: Not common. Found on slides 273, 345.
Comments: A cosmopolitan species.

N. ramosissima var. *caspia* Grun. Fig. 187

References: Cleve 1894–95, 27(3), p. 26; Hendey 1964, p. 194, pl. 30, fig. 9.
Description: Length 44 μm, breadth 7 μm, 12 striae in 10 μm.
Distribution: Common. Found on slide 259.
Comments: A cosmopolitan species.

N. reichardtii Grun. Fig. 188

References: Cleve 1894–95, 27(3), p. 65.
Description: Length 21 μm, breadth 9 μm, 16 striae in 10 μm.
Distribution: Rare. Found on slide 273.
Comments: A cosmopolitan species.

N. rhaphoneis (Ehrenb.) Grun. Fig. 189

References: Cleve 1894–95, 27(3), p. 36, pl. 1, fig. 27; Foged 1975, p. 42, pl. 20, fig. 13.
Description: Length 19–36 μm, breadth 9–14 μm, 7–10 striae, 18–20 linolae in 10 μm.
Distribution: Common. Found on slides 12, 341, 351, 259.

N. transfuga Grun. Fig. 190

References: Cleve 1894–95, 27(3), p. 48; Hustedt 1961–66, 7(3), p. 697, fig. 1693.
Description: Length 90–126 μm, breadth 40–61 μm, 8–10 striae and 6 puntae in 10 μm.
Distribution: Common. Found on slide 79.

N. transitans Cl. Fig. 191

References: Cleve 1894–95, 27(3), p. 27.
Description: Length 59–84 μm, breadth 12–16 μm, 7–8 striae in 10 μm.
Distribution: Not common. Found on slide 345.

N. yarrensis Grun. Figs. 192–193

References: Cleve 1894–95, 27(3), p. 69; Foged 1984, p. 72, pl. 46, fig. 1.
Description: Length 60–115 μm, breadth 18–33 μm, 3–5 middle and 5–7 polar striae in 10 μm.
Distribution: Rare. Found on slide 19.
Comments: A cosmopolitan species.

N. zostereti Grun. Fig. 194

References: Cleve 1894–95, 27(3), p. 31; Foged 1984, p. 72, pl. 45, fig, 13 & pl, 46, figs. 3 & 4.
Description: Length 66–74 μm, breadth 13–17 μm, 6–8 striae in 10 μm.
Distribution: Common. Found on slides 12, 125, 175, 335, 337, 343.
Comments: A cosmopolitan species.

Nitzschia Hassall 1845

N. amphibia Grun. Figs. 195–196

References: Foged 1979, p. 85, pl. 42, fig. 6; pl. 43, figs. 10 & 11; Navarro 1982, p. 52, pl. 34, fig. 6.
Description: Length 19–22 μm, breadth 3–5 μm, 14–15 striae, 7–10 fibulae in 10 μm.
Distribution: Common. Found on slide 12.
Comments: A cosmopolitan species. Freshwater to marine.

N. apiculata (Greg.) Grun. Fig. 197

References: Hendey 1964, p. 279; Foged 1984, p. 74, pl. 24, fig. 10.
Description: Length 29–62 μm, breadth 8–10 μm, 16 striae, 13–14 fibulae in 10 μm.
Distribution: This species is common and widespread in muddy shores (Hendey, 1964). Common. Found on slides 12, 333, 337.
Comments: A cosmopolitan species.

N. bilobata var. *minor* Grun. Fig. 198

References: Cupp 1943, p. 200, fig. 152.
Description: Length 99–160 μm, breadth 6–11 μm, 24–28 striae, 7–11 fibulae in 10 μm.
Distribution: Not common. Slide 278, 341.
Comments: Brackish to marine.

N. brebissonii var. *borealis* Grun. Fig. 199

References: Cleve 1896, p. 21, pl. 1, figs 28–32.
Description: Length 122 μm, breadth 10 μm, 16–18 striae, 6–7 fibulae in 10 μm.
Distribution: Not common. Found on slide 278.

N. cocconeiformis Grun. Fig. 200

References: Foged 1975, p. 45, pl. 29, fig. 6.
Description: Length 27–59 μm, breadth 16–26 μm, 4–6 costae, 4–6 fibulae in 10 μm.
Distribution: Rare. Found on slides 323, 339.
Comments: A cosmopolitan species. Freshwater to marine.

N. commutata Grun. Fig. 201

References: Tiffany & Britton 1952, p. 288, pl. 77, fig. 903.
Description: Length 30–80 μm, breadth 5–10 μm, 20–24 striae, 6–10 fibulae in 10 μm.
Distribution: Not common. Found on slide 337.
Comments: A cosmopolitan species. Freshwater.

N. constricta (Greg.) Grun. Figs. 202–203

References: Prowse 1962, p. 65, pl. 19, fig. d; Navarro 1982, p. 53, pl. 34, fig. 8.
Description: Length 16–31 μm, breadth 6–11 μm, 14–20 striae, 8–10 fibulae in 10 μm.
Distribution: Common. Found on slides 1,2, 257, 273, 278, 341, 345, 347, 357.
Comments: A cosmopolitan species.

N. granulata Grun. Figs. 204–206

References: Hendey 1964, p. 278; Foged 1979, p. 87, pl. 40, figs. 14 & 15.
Description: Length 24–48 μm, breadth 14–17 μm, 4–6 puncta in 10 μm.
Distribution: Not common. Found on slides 339, 357.
Comments: A cosmopolitan species.

N. ignorata Krasske. Fig. 207

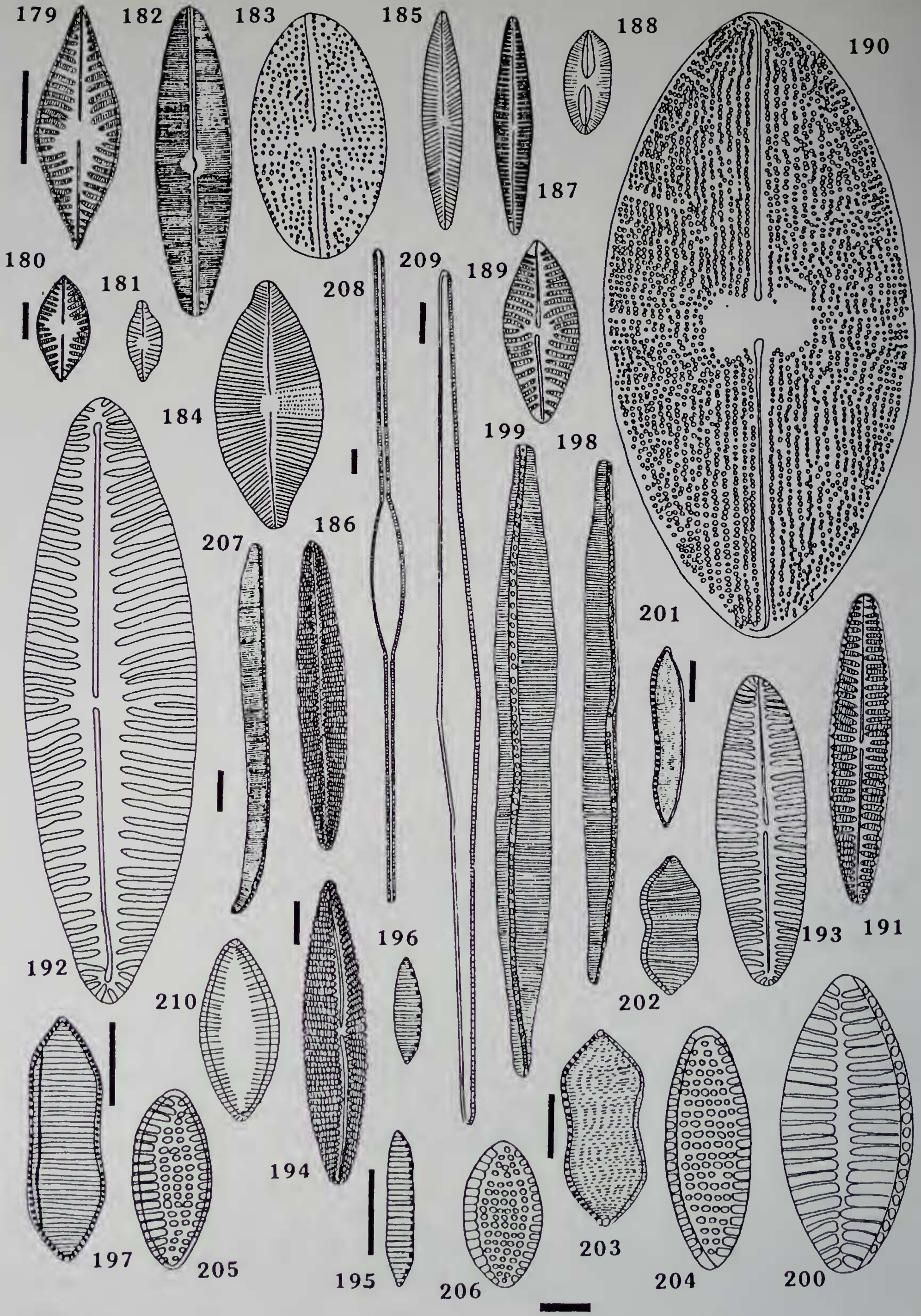
References: Foged 1966, p. 121, pl. 24, fig. 5; Foged 1979, p. 87, pl. 43, figs. 5 & 6.
Description: Length 87 μm, breadth 5 μm, 28 striae, 7–10 fibulae in 10 μm.
Distribution: Common. Found on slide 12.
Comments: A cosmopolitan species. Freshwater to marine.

N. longissima (Bréb.) Ralfs. Figs. 208–209

References: Hendey 1964, p. 283; Foged 1975, p. 46, pl. 29, fig. 7.
Description: Length 202–311 μm, breadth 10–13 μm, 6–12 fibulae in 10 μm.
Distribution: Common. Found on slides 1, 3.
Comments: A cosmopolitan species.

N. navicularis var. *typica* Mh. Fig. 210

References: Cleve-Euler 1952, 3(3), p. 56, fig 1427a.
Description: Length 34–37 μm, breadth 15–16 μm, 6–7 striae in 10 μm.
Distribution: Not common. Found on slides 129, 339.
Comments: A cosmopolitan species.



Figs. 179–210 (horizontal common scale bar and those of Figs. 179, 180, 194, 195, 197, 201, 203 and 207–209 = 10 μm)

Figs. 179–180. *Navicula platessa.* Fig. 181. *N. platyventris.* Fig. 182. *N. plicata.* Fig. 183. *N. praetexta.* Fig. 184. *N. pusilla* var. *jamalinensis.* Fig. 185. *N. radiosa.* Fig. 186. *N. ramosissima.* Fig. 187. *N. ramosissima* var. *caspia.* Fig. 188. *N. reichardtii.* Fig. 189. *N. rhaphoneis.* Fig. 190. *N. transfuga.* Fig. 191. *N. transitans.* Figs. 192–193. *N. yarrensis.* Fig. 194. *N. zostereti.* Fig. 195–196. *Nitzschia amphibia.* Fig. 197. *N. apiculata.* Fig. 198. *N. bilobata* var. *minor.* Fig. 199. *N. brebissonii* var. *borealis.* Fig. 200. *N. cocconeiformis.* Fig. 201. *N. commutata.* Figs. 202–203. *N. constricta.* Figs. 204–206. *N. granulata.* Fig. 207. *N. ignorata.* Figs. 208–209. *N. longissima,* valve view and girdle view. Fig. 210. *N. navicularis* var. *typica.*

N. panduriformis Greg. Fig. 211

References: Hendey 1964, p. 279; Foged 1975, p. 47, pl. 29, figs. 12 & 13.
Description: Length 36–66 μm, breadth 13–30 μm, 14–16 striae, 6–10 fibulae in 10 μm.
Distribution: Common. Found on slides 100, 141, 343.
Comments: A cosmopolitan species.

N. parvula var. *terricola* Lund. Fig. 212

References: Foged 1979, p. 89; pl. 43, fig. 18.
Description: Length 40 μm, breadth 5 μm, 7–8 fibulae in 10 μm. Freshwater.
Distribution: Common. Found on slide 257.

N. punctata (W. Sm.) Grun. Fig. 213

References: Hendey 1964, p. 278. pl. 39, fig. 11; Foged 1979, p. 89, pl. 40, fig. 13; pl. 41, fig. 7; pl. 42, fig. 3.
Description: Length 32–33 μm, breadth 19–20 μm, 6 striae in 10 μm.
Distribution: Rare. Found on slide 95.
Comments: A cosmopolitan species.

N. punctata var. *coarctata* Grun. Fig. 214

References: Hendey 1964, p. 278; Foged 1984, p. 80, pl. 56, fig. 7.
Description: Length 28–35 μm, breadth 10–12 μm, 11–12 striae in 10 μm.
Distribution: Common. Found on slides 1, 259, 350, 353.
Comments: A cosmopolitan species. Occasionally found in freshwater.

N. sigma var. *rigida* (Kütz.) Grun. Figs. 215–218

References: Hendey 1964, p. 282; Caljon 1983, p. 140, pl. 30, figs. 11–12.
Description: Length 43–108 μm, breadth 5–10 μm, 20 striae, 6–8 fibulae in 10 μm.
Distribution: Common. Found on slides 12, 93, 175, 333, 337, 341, 345, 347, 357, 359.
Comments: A cosmopolitan species.

N. sigmoidea (Ehrenb.) W. Sm. Fig. 219

References: Cleve-Euler 1952, 3(3), p. 72; Gerloff & Natour 1982, p. 200, pl. 19, fig. 1.
Description: Length 164–331 μm, breadth 11–13 μm, 23–25 striae 5–7 fibulae in 10 μm.
Distribution: Not common. Found on slides 1, 175, 355.
Comments: A cosmopolitan species. Freshwater to marine.

N. subtilis (Kütz.) Grun. Fig. 220

References: Prowse 1962, p. 71, pl. 19, fig. p; pl. 20, fig. f.
Description: Length 56–127 μm, breadth 4–5 μm, 28–30 striae 8–10 fibulae in 10 μm.
Distribution: Not common. Found on slides 12, 257.
Comments: A cosmopolitan species (?). Freshwater.

N. tryblionella var. *victoriae* Grun. Fig. 221

References: Foged 1975, p. 47, pl. 28, fig. 4; Fungladda, Kaezmarska & Rushforth 1983, p. 44, fig. 274.
Description: Length 73 μm, breadth 40 μm, 5 costae, 16 striae, 9 fibulae in 10 μm.
Distribution: Rare. Found on slide 12.
Comments: A cosmopolitan species. Freshwater to marine.

N. vermicularis (Kütz.) Hantz. Fig. 222

References: Tiffany & Britton 1952, p. 286, pl. 76, fig. 890.
Description: Length 127 μm, breadth 4–5 μm, 7–9 fibulae in 10 μm.
Distribution: Rare. Found on slides 1, 81, 333.
Comments: A cosmopolitan species. Freshwater to brackish.

Odontella Ag. 1832

O. aurita (Lyngb.) Ag. (=*Biddulphia*) Figs. 223–225

References: Hustedt 1930, 7(1), p. 846, fig. 501; Hendey 1964, p. 103, pl. 24, fig. 6.
Description: Length 27–54 μm, breadth 22 μm, puncta 9–12 in 10 μm. Usually in long chains, sometimes free-floating.
Distribution: Very common. Found on slides 2, 3, 81, 100, 259, 278.
Comments: A cosmopolitan species.

O. aurita var. *obtusa* (Kütz.) Hust. (=*Biddulphia*). Fig. 226

References: Caljon 1983, p. 107, pl. 15, fig. 21.
Description: Length 42–56 μm, breadth 50–54 μm, puncta 9–10 in 10 μm. Solitary or united into long chains.
Distribution: Common. Found on slides 278, 355.
Comments: A cosmopolitan species.

Opephora Petit 1888

O. martyi Hérib. Figs. 227–228

References: Patrick & Reimer 1966, p. 115, pl. 3, fig. 3; Caljon 1983, p. 114, pl. 18, figs. 5, 6.
Description: Length 14–30 μm, breadth 5–6 μm, 9–10 striae in 10 μm.
Distribution: Rare. Found on slides 273.
Comments: A cosmopolitan species.

O. schwartzii (Grun.) Petit. Fig. 229

References: Hendey 1964, p. 159, pl. 36, figs. 8,9; Patrick & Reimer 1966, p. 116, pl. 3, fig. 1.
Description: Length 45–53 μm, breadth 10 μm, 4–5 striae in 10 μm.
Distribution: Rare. Found on slides 38, 273.
Comments: A cosmopolitan species (?).

Paralia Heiberg 1863

P. sulcata (Ehrenb.) Cl. Figs. 230–231

References: Boyer 1926–27, p. 25; Hendey 1964, p. 73, pl. 23, fig. 5.
Description: Diameter 15–55 μm.
Distribution: Very common. Found on slides 38, 79, 141, 341, 343, 351, 355.
Comments: A cosmopolitan species.

Plagiodiscus Grun. & Eulenst. 1867

P. nervatus Grun. Fig. 232

References: Hendey 1970, p. 160, pl. 4, fig. 39; Foged 1975, p. 49, pl. 31, figs. 4,5.

Description: Length 46–51 μm, breadth 24 μm, 3–4 costae, 12–13 striae in 10 μm.
Distribution: Not common. Found on slides 333, 345.

Plagiogramma Grev. 1859

P. staurophorum (Greg.) Heiberg. Fig. 233

References: Hendey 1964, p. 166, pl. 36, fig. 1.
Description: Length 35 μm, breadth 8 μm, 17 puncta in 10 μm. Solitary or colonial.
Distribution: Rare. Found on slides 38, 116.

Pleurosigma W. Sm. 1852

P. aestuarii (Bréb.) W. Sm. Figs. 234–235

References: Cleve 1894–95, 26(2) p. 42; Hendey 1964, p. 247, pl. 36, fig. 5, pl. 41, fig. 5.
Description: Length 112–188 μm, breadth 26–40 μm, 19–21 striae in 10 μm.
Distribution: Not common. Found on slides 357, 359.
Comments: Common in temperate waters.

P. delicatulum W. Sm. Fig. 236

References: Cleve 1894–95, 26(2) p. 37; Patrick & Reimer 1966, p. 336, pl. 28, figs. 4a–b.
Description: Length 153 μm, breadth 15 μm, 25 striae in 10 μm.
Distribution: Rare. Found on slide 2.
Comments: A cosmopolitan species (?). Freshwater, brackish to marine.

P. elongatum W. Sm. Fig. 237

References: Gonzalves & Gandhi 1953, 2-p. 244, fig. 70; Patrick & Reimer 1966, p. 334, fig. 1a–c.
Description: Length 124–154 μm, breadth 23–26 μm, 17–19 transverse, 16–17 oblique striae in 10 μm.
Distribution: Not common. Found on slide 91.
Comments: A cosmopolitan species. Freshwater to marine.

P. formosum W. Sm. Fig. 238

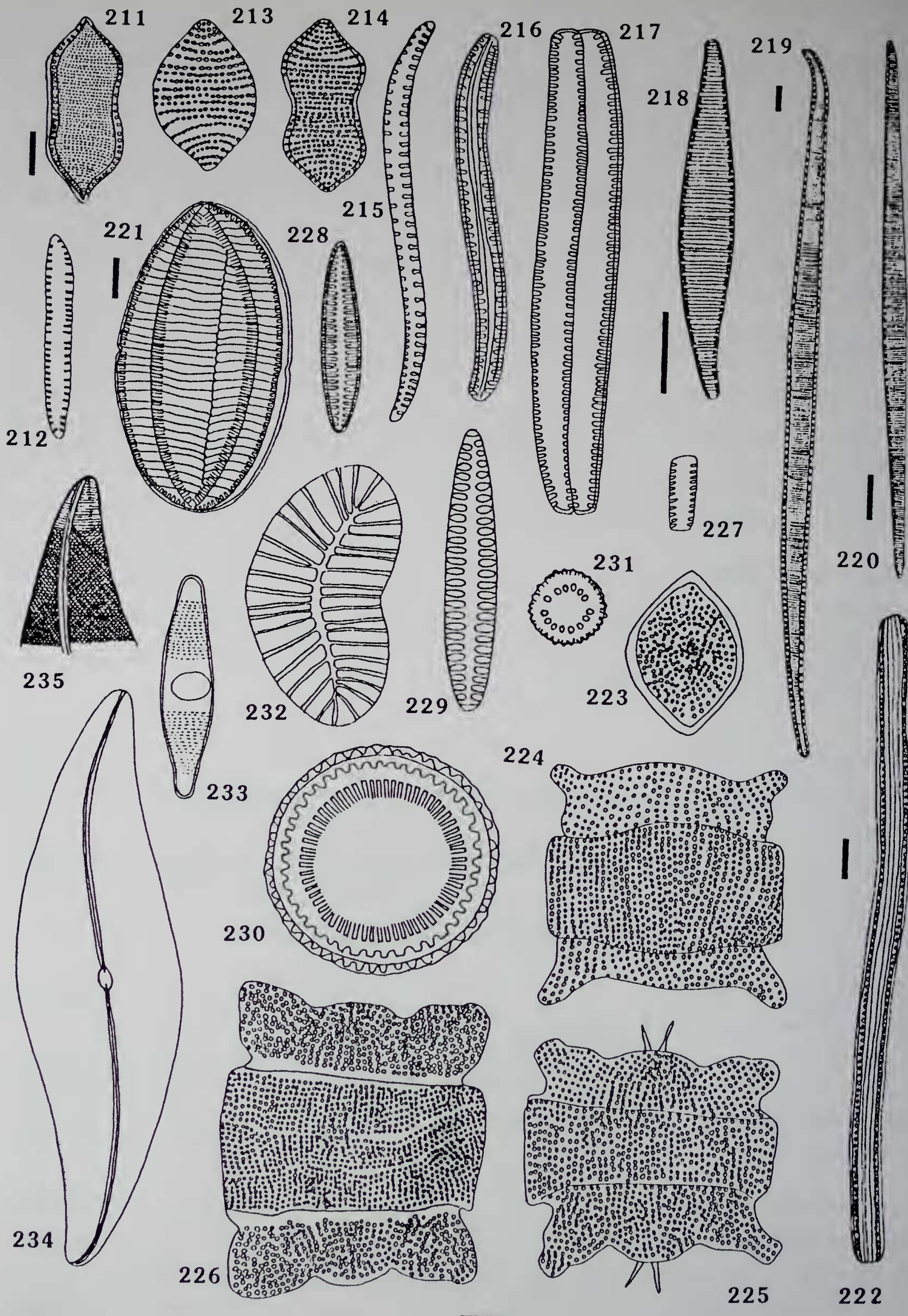
References: Cleve 1894–95, 26(2) p. 45, Hendey 1964, p. 242.
Description: Length 125–326 μm, breadth 22–36 μm, 14–15 transverse, 10–14 oblique striae in 10 μm.
Distribution: Common. Found on slides 319, 343, 345, 347.
Comments: A cosmopolitan species.

P. intermedium W. Sm. Fig. 239

References: Cleve 1894–95, 26(2) p. 34, Hendey 1964, p. 244.
Description: Length 166–196 μm, breadth 17–19 μm, 20 striae in 10 μm.
Distribution: Common. Found on slide 278.
Comments: Common in temperate seas.

P. majus Grun. Figs. 240–241

References: Cleve 1894–95, 26(2) p. 44, pl. 4, fig. 15.
Description: Length 295–348 μm, breadth 40–45 μm, 15 transverse, 12 oblique striae in 10 μm.
Distribution: Rare. Found on slides 3, 79.



Figs. 211–235 (horizontal common scale bar and those of Figs. 211 and 218–222 = 10 μm)

Fig. 211. *Nitzschia panduriformis.* Fig. 212. *N. parvula* var. *terricola.* Fig. 213. *N. punctata.* Fig. 214. *N. punctata* var. *coarctata.* Figs. 215–218. *N. sigma* var. *rigida*, valve view, girdle view and colony formation. Fig. 219. *N. sigmoidea.* Fig. 220. *N. subtilis.* Fig. 221. *N. tryblionella* var. *victoriae.* Fig. 222. *N. vermicularis.* Figs. 223–225. *Odontella aurita.* Fig. 226. *O. aurita* var. *obtusa.* Figs. 227–228. *Opephora martyi*, valve view and girdle view. Fig. 229. *O. schwartzii.* Figs. 230–231. *Paralia sulcata.* Fig. 232. *Plagiodiscus nervatus.* Fig. 233. *Plagiogramma staurophorum.* Figs. 234–235. *Pleurosigma aestuarii.*

P. marinum Donk. Fig. 242

References: Cleve 1894–95, 26(2) p. 37, Hendey 1964, p. 247, pl. 35, fig. 8.
Description: Length 128 μm, breadth 27 μm, 21 transverse, 18 oblique striae in 10 μm.
Distribution: Not common. Found on slide 278.

P. normanii Ralfs. Fig. 243

References: Cleve 1894–95, 26(2) p. 40; Hendey 1964, p. 244.
Description: Length 128–132 μm, breadth 26–31 μm, 20 transverse, 17–22 oblique striae in 10 μm.
Distribution: Rare. Found on slides 12, 183.

P. nubecula var. *mauritiana* Grun. Fig. 244

References: Cleve 1894–95, 26(2) p. 35.
Description: Length 127 μm, breadth 13 μm, 22 striae in 10 μm.
Distribution: Not common. Found on slide 2.
Comments: A cosmopolitan species (?).

P. salinarum (Grun.) Cl. Figs. 245–246

References: Cleve 1894–95, 26(2) p. 39; Patrick & Reimer 1966, p. 333, pl. 27, figs. 2a–c.
Description: Length 107 μm, breadth 19 μm, 25 transverse, 30 oblique striae in 10 μm.
Distribution: Not common. Found on slides 2, 257.
Comments: A cosmopolitan species. Freshwater to brackish.

P. salinarum var. *boyeri* (Keeley) Reim. Figs. 247–248

References: Patrick & Reimer 1966, p. 334, pl. 27, figs. 4a–c.
Description: Length 92–100 μm, breadth 11–14 μm, 24–25 transverse, 30 oblique striae in 10 μm.
Distribution: Rare. Found on slide 116.
Comments: Freshwater to marine.

Podocystis Kütz. 1844

P. adriatica Kütz. Fig. 249

References: Hendey 1964, p. 169, pl. 27, fig. 4; Foged 1984, p. 89, pl. 28, fig. 9; pl. 30, figs. 7–8.
Description: Length 64–74 μm, breadth 48–57 μm, 3–4 costae, 5–7 areolae in 10 μm.
Distribution: Common. Found on slides 333, 345.
Comments: A cosmopolitan species.

Psammodiscus Kütz. 1844

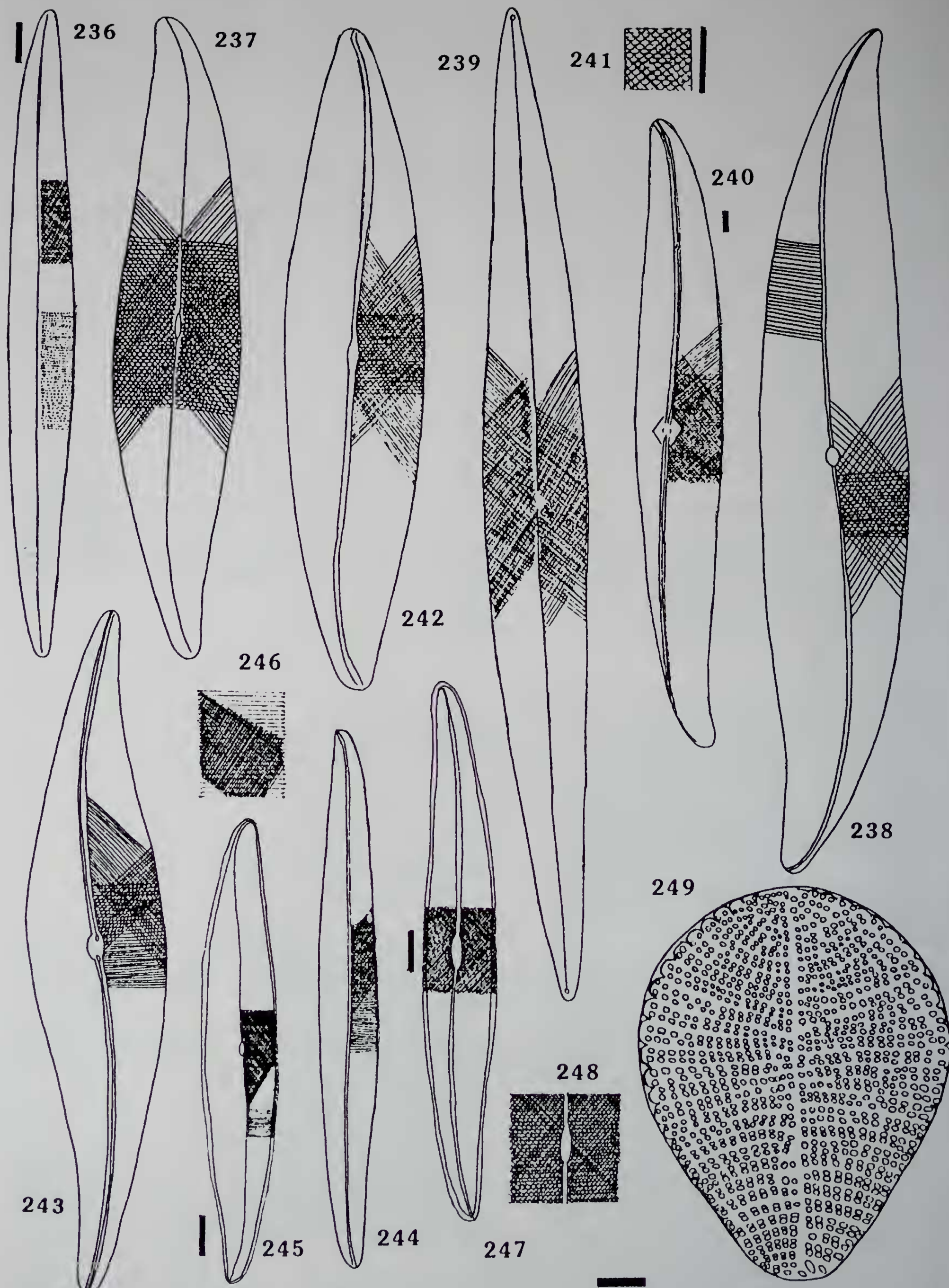
P. nitidus (Greg.) Round & Mann. Figs. 250–251

References: Hendey 1964, p. 76, pl. 23, fig. 12; Round & Mann, 1980.
Description: Diameter 29–50 μm.
Distribution: Not common. Found on slides 12, 48, 120.
Comments: A cosmopolitan species.

Pyxidicula Ehrenb. 1833

P. africana Cholnoky. Fig. 252

References: Schoeman 1972, p. 86, figs. 7, 8.



Figs. 236–249 (horizontal common scale bar and those of Figs. 236, 240, 241, 245 and 247 = 10 μm)

Fig. 236. *Pleurosigma delicatulum.* Fig. 237. *P. elongatum.* Fig. 238. *P. formosum.* Fig. 239. *P. intermedium.* Figs. 240–241. *P. majus.* Fig. 242. *P. marinum.* Fig. 243. *P. normanii.* Fig. 244. *P. nubecula* var. *mauritiana.* Figs. 245–246. *P. salinarum*, valve view and details of striations. Figs. 247–248. *P. salinarum* var. *boyeri*, valve view and details of striations. Fig. 249. *Podocystis adriatica.*

Description: Diameter 22–48 μm, 5–7 rows of areolae and 12 marginal striae 10 μm.
Distribution: Very common. Found on slides 3, 79, 278, 339, 351.

Rhabdonema Kütz. 1844

R. adriaticum Kütz. Fig. 253

References: Hendey 1964, p. 172.
Description: Length 88 μm. Colonial.
Distribution: Not common. Found on slides 2, 3, 91, 116.

Rhaphoneis Ehrenb. 1844

R. amphiceros Ehrenb. Fig. 254

References: Hendey 1964, p. 154, pl. 26, figs. 1–4; Navarro 1982, p. 24, pl. 13, fig. 9.
Description: Length 30–42 μm, breadth 16–28 μm, 5–8 striae in 10 μm.
Distribution: Common. Found on slides 49, 91, 93, 125.
Comments: A cosmopolitan species.

R. amphiceros var. *tetragona* Grun. Fig. 255

References: Hendey 1970, p. 122, pl. 4, fig. 41; Foged 1975, p. 51, pl. 11, figs. 10, 11.
Description: Length of side 32–36 μm, 6 striae in 10 μm.
Distribution: Not common. Found on slides 91, 119.

R. castracanii Grun. Fig. 256

References: Wood 1963, p. 279, pl. 11, fig; 228.
Description: Length 21–43 μm, breadth 21–26 μm, 4–6 striae in 10 μm.
Distribution: Not common. Found on slides 91, 132.

Rhopalodia O. Müller 1897

R. gibba var. *ventricosa* (Kütz.) H. & M. Perag. Fig. 257

References: Hendey 1964, p. 272; Patrick & Reimer 1975, p. 190, pl. 28, figs. 3, 4.
Description: Length 48–54 μm, breadth 12–15 μm, 5 costae, 12–13 striae in 10 μm.
Distribution: Common. Found on slide 12.
Comments: A cosmopolitan species. Freshwater to marine.

R. gibberula (Ehrenb.) O. Müll. Figs. 258–259

References: Prowse 1962, p. 62, pl. 22, fig. a; Patrick & Reimer 1975, p. 191, pl. 28, fig. 6.
Description: Length 28–55 μm, breadth 16–31 μm in girdle, 7–12 μm in valve, 3–5 costae, 16–17 striae in 10 μm.
Distribution: Common. Found on slides 12, 91, 337, 339, 350.
Comments: A cosmopolitan species. Freshwater to marine.

R. gibberula var. *vanheurckii* O. Müll. Fig. 260

References: Patrick & Reimer 1975, p. 192, pl. 28, fig. 7.
Description: Length 20–38 μm, breadth 11–12 μm in girdle, 5–7 μm in valve, 2–5 costae, 14 striae in 10 μm.
Distribution: Rare. Found on slide 343.
Comments: A cosmopolitan species. Freshwater and brackish.

Stauroneis Ehrenb. 1841

S. membranaceae (Cl.) Hust. Fig. 261

References: Hendey 1964, p. 221; Navarro 1982, p. 325, figs. 106–107.
Description: Length 58 μm, pervalvar axis 55 μm, 25 striae in 10 μm.
Distribution: Rare. Found on slide 4.

Stephanopyxis Grun. 1884

S. turris var. *polaris* Grun. Fig. 262

References: Hustedt 1930, 7(1), p. 306, fig. 144.
Description: Diameter 65–72 μm, 1 1/2–1 3/4 areolae in 10 μm. Solitary or united to form short chains.
Distribution: Not common. Found on slides 95, 141.

Striatella Ag. 1832

S. unipunctata (Lyng.) Ag. Fig. 263

References: Cleve-Euler 1953, 4(1), p. 8, fig. 300; Hendey 1964, p. 161, pl. 26, figs 17, 18.
Description: Length 72 μm, breadth 18 μm, 25–30 oblique striae in 10 μm. Colonial.
Distribution: Rare. Found on slide 37.
Comments: A cosmopolitan species.

Surirella Turpin 1828

S. amoricana Perag. Fig. 264

References: Hendey 1964, p. 289, pl. 40, fig. 6; Foged 1975, p. 53, pl. 30, figs. 3–5.
Description: Length 34–56 μm, breadth 21–42 μm, 12–13 marginal striae, 1.5–2 costae in 10 μm.
Distribution: Common. Found on slides 75, 93, 345.

S. fastuosa (Ehrenb.) Kütz. Fig. 265

References: Cleve-Euler 1952, 3(3), p. 115, fig. 1571; Hendey 1964, p. 288, pl. 40, fig. 4.
Description: Length 56–104 μm, breadth 42–66 μm, 14 marginal striae, 1–3 costae in 10 μm.
Distribution: Common. Found on slides 4, 343, 347, 350.
Comments: A cosmopolitan species.

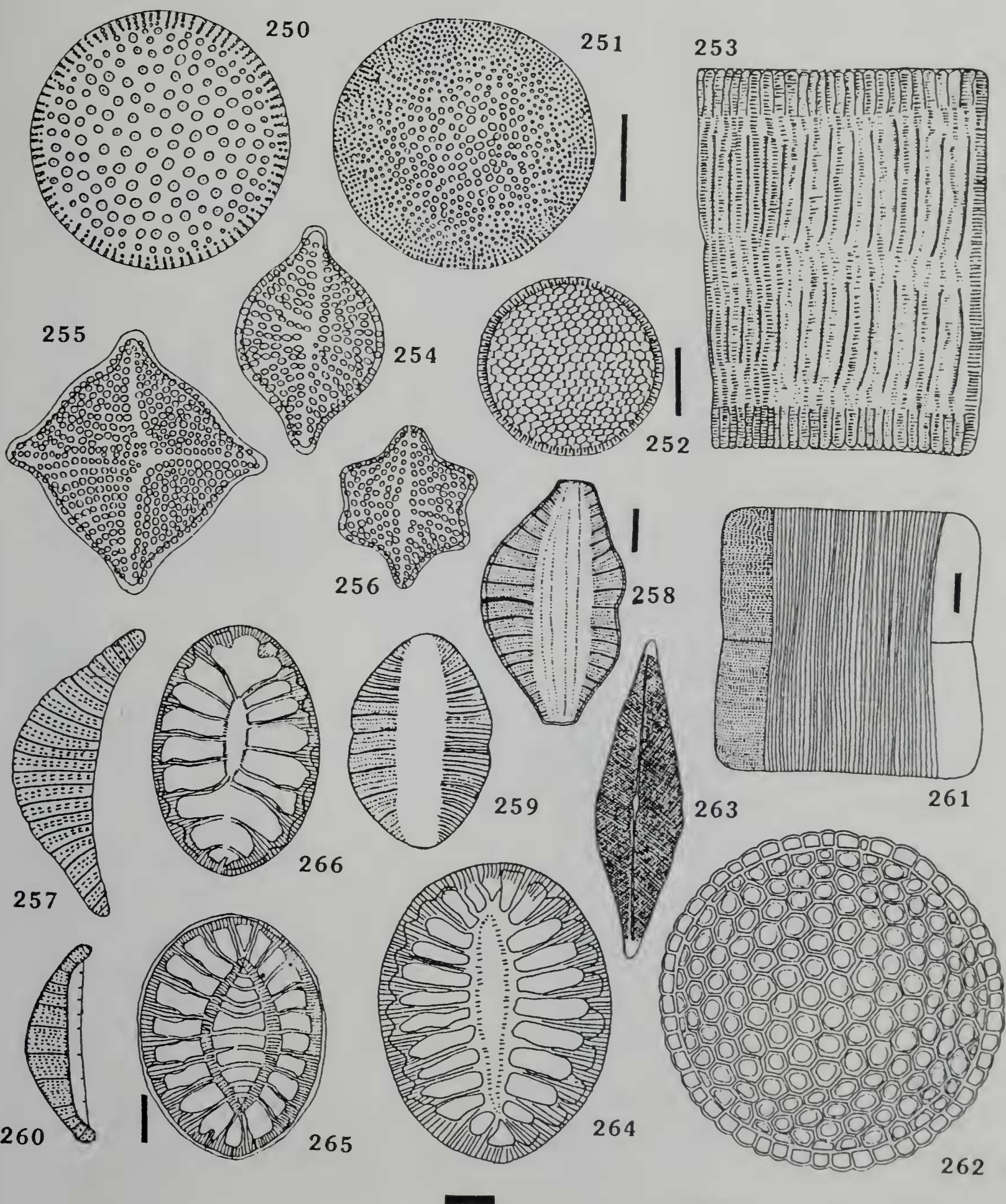
S. fastuosa var. *recedens* (A. Sch.) Cl. Fig. 266

References: Cupp 1943, p. 208, fig. 160.
Description: Length 38–47 μm, breadth 24–34 μm, 16–18 marginal striae, 2–3 costae in 10 μm.
Distribution: Not common. Found on slides 1, 12, 138, 343.

Synedra Ehrenb. 1830

S. amphicephala Kütz. Fig. 267

References: Patrick & Reimer 1966, p. 138, pl. 5, fig. 7.
Description: Length 64–82 μm, breadth 5–6 μm, 12–13 striae in 10 μm.
Distribution: Not common. Found on slides 337, 351.
Comments: Freshwater.



Figs. 250–266 (horizontal common scale bar and those of Figs. 251, 252, 258, 261, 265 = 10 μm)

Figs. 250–251. *Psammodiscus nitidus.* Fig. 252. *Pyxidicula africana.* Fig. 253. *Rhabdonema adriaticum,* colony forming ribbon-like chain. Fig. 254. *Rhaphoneis amphiceros.* Fig. 255. *Rhaphoneis amphiceros* var. *tetragona.* Fig. 256. *R. castracanii.* Fig. 257. *Rhopalodia gibba* var. *ventricosa.* Figs. 258–259. *R. gibberula.* Fig. 260. *R. gibberula* var. *vanheurckii.* Fig. 261. *Stauroneis membranaceae,* girdle view. Fig. 262. *Stephanopyxis turris* var. *polaris.* Fig. 263. *Striatella unipunctata.* Fig. 264. *Surirella amoricana* Fig. 265. *S. fastuosa.* Fig. 266. *S. fastuosa* var. *recedens.*

S. crystallina (Ag.) Kütz. Fig. 268

References: Hendey 1964, p. 164; Patrick & Reimer 1966, p. 157, pl. 8, figs. 4a–c.
Description: Length 110–195 μm, breadth 10–17 μm, 9 striae in 10 μm.
Distribution: Not common. Found on slides 1, 4.
Comments: A cosmopolitan species.

S. demerare Grun. Fig. 269

References: Boyer 1926–27, p. 206; Patrick & Reimer 1966, p. 139, pl. 5, fig. 10.
Description: Length 68–124 μm, breadth 6–9 μm (girdle), 8–9 striae in 10 μm.
Distribution: Very common. Freshwater. Found on slides 257, 273, 335, 337, 343, 345.

S. fasciculata var. *truncata* (Grev.) Patr. Figs. 270–271

References: Patrick & Reimer 1966, p. 142, pl. 5, fig. 16.
Description: Length 42–54 μm, breadth 5–8 μm, 9–14 striae in 10 μm.
Distribution: Very common. Found on slides 1, 75, 257, 273, 335, 337, 355.
Comments: A cosmopolitan species. Freshwater to marine.

S. formosa Hantz. Figs. 272–273

References: Boyer 1926–27, p. 209; Navarro 1982, p. 260, figs. 61-63.
Description: Length 280–614 μm, breadth 16–29 μm, 8–9 striae in 10 μm.
Distribution: Common. Found on slides 1, 116, 124, 335, 343, 350, 357.
Comments: A cosmopolitan species.

S. gaillonii (Bory) Ehrenb. Fig. 274

References: Hendey 1964, p. 163; Patrick & Reimer 1966, p. 148, pl. 6, fig. 16.
Description: Length 69–111 μm, breadth 5–6 μm, 9–10 striae in 10 μm.
Distribution: Rare. Found on slides 278, 335.
Comments: A cosmopolitan species.

S. hennedyana Greg. Fig. 275

References: Hendey 1964, p. 164, pl. 26, fig. 7.
Description: Length 809 μm, breadth 11 μm.
Distribution: Not common. Found on slides 1, 116, 132, 333.
Comments: A cosmopolitan species.

S. provincialis var. *tortuosa* Grun. Fig. 276

References: Foged 1975, p. 54, pl. 10, fig. 10.
Description: Length 94 μm, breadth 6 μm.
Distribution: Very common. Found on slide 341.

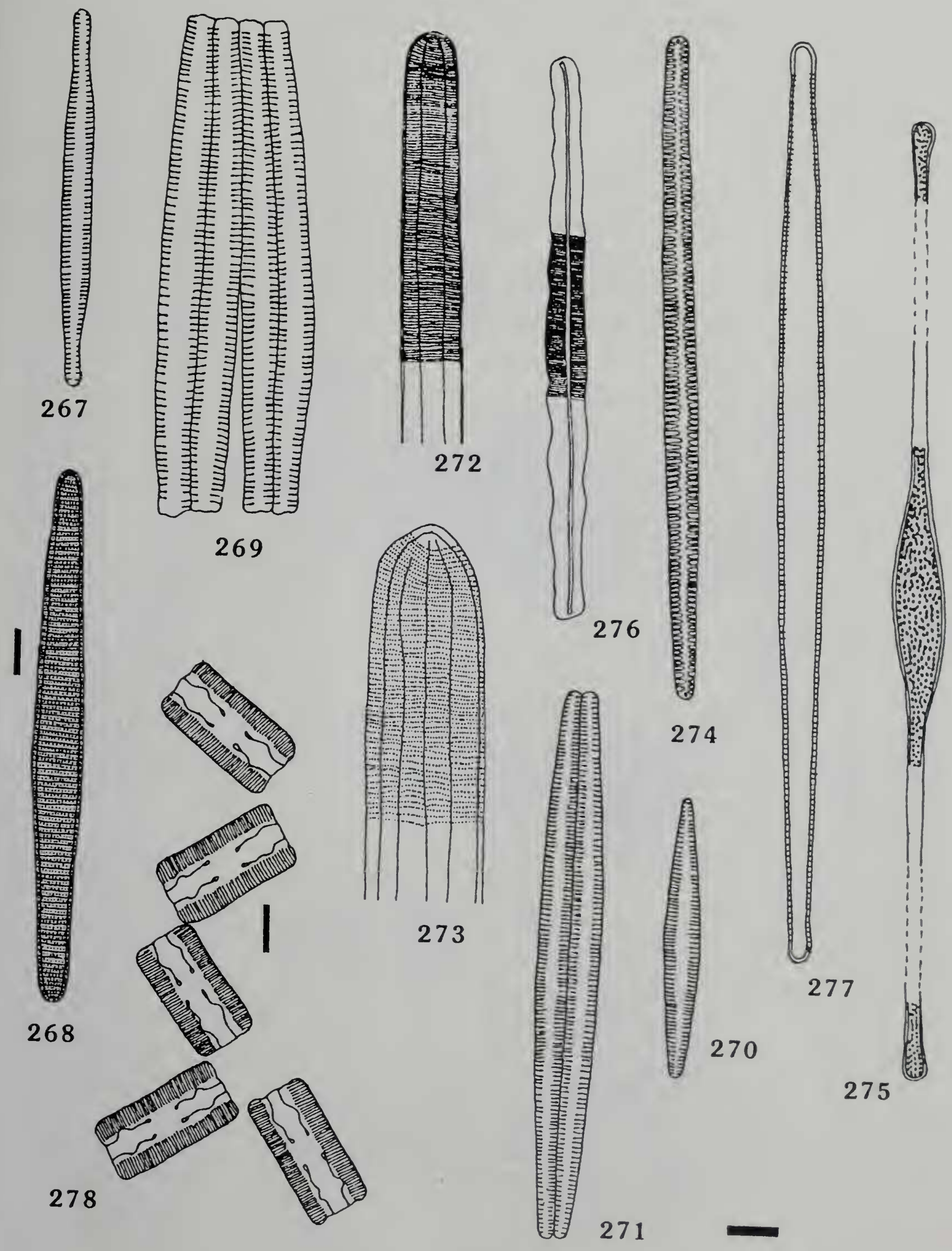
S. tabulata var. *grandis* Mereschk. Fig. 277

References: Hustedt 1959, 7(2), p. 219, fig. 710g.
Description: Length 155 μm, breadth 7 μm, 12 striae in 10 μm.
Distribution: Not common. Found on slide 350.
Comments: A cosmopolitan species.

Tabellaria Ehrenb. 1839

T. fenestrata (Lyng.) Kütz. Fig. 278

References: Patrick & Reimer 1966, p. 103, pl. 1, figs. 1–2.



Figs. 267–278 (horizontal common scale bar and those of Figs. 268 and 278 = 10 μm)

Fig. 267. *Synedra amphicephala.* Fig. 268. *S. crystallina.* Fig. 269. *S. demerare*, a four-celled colony. Figs. 270–271. *S. fasciculata* var. *truncata.* Figs. 272–273. *S. formosa.* Fig. 274. *S. gaillonii.* Fig. 275. *S. hennedyana.* Fig. 276. *S. provincialis* var. *tortuosa.* Fig. 277. *S. tabulata* var. *grandis.* Fig. 278. *Tabellaria fenestrata*, cells in zig-zag chain, girdle view.

Description: Length 26–38 μm, 15–20 striae in 10 μm.
Distribution: Very common. Found on slides 1, 93, 257, 273, 319, 337, 351, 355.
Comments: A cosmopolitan species.

Thalassionema Grun. 1880

T. nitzschioides Hust. Figs. 279–280

References: Hendey 1964, p. 165; Schoeman 1972, p. 88, figs. 2–4.
Description: Length 26–42 μm, breadth 4–5 μm, 8–12 puncta in 10 μm. Solitary or colonial.
Distribution: Common. Found on slides 12, 319, 321, 337, 339, 347.
Comments: A cosmopolitan species.

Thalassiosira Cl. 1873

T. eccentrica (Ehrenb.) Cl. Fig. 281

References: Foged 1979, p. 112, pl. 4, fig. 4.
Description: Diameter 24–60 μm, 10–17 marginal striae, 4–7 areolae in the middle and 6–9 near the margin, 2–4 irregular teeth in 10 μm.
Distribution: Common. Found on slides 3, 33, 278, 315; 351.
Comments: A cosmopolitan species. Fig. 45.

Trachyneis Cl. 1894

T. antillarum Cl. Fig. 282

References: Cleve 1878, p. 8, pl. 2, fig. 11; Cleve 1894–95, 26(2) p. 193.
Description: Length 149 μm, breadth 36 μm, 8 striae in 10 μm.
Distribution: Not common. Found on slide 359.
Comments; A cosmopolitan species (?).

T. antillarum var. *kurzii* Grun. Fig. 283

References: Cleve 1878, p. 8, fig. 12a; Cleve 1894–95, 26(2) p. 193.
Description: Length 83–98 μm, breadth 37–40 μm, 9–11 striae in 10 μm.
Distribution: Common. Found on slides 345, 351, 353, 357.
Comments: Brackish to marine.

T. aspera (Ehrenb.) Cl. Figs. 284–285

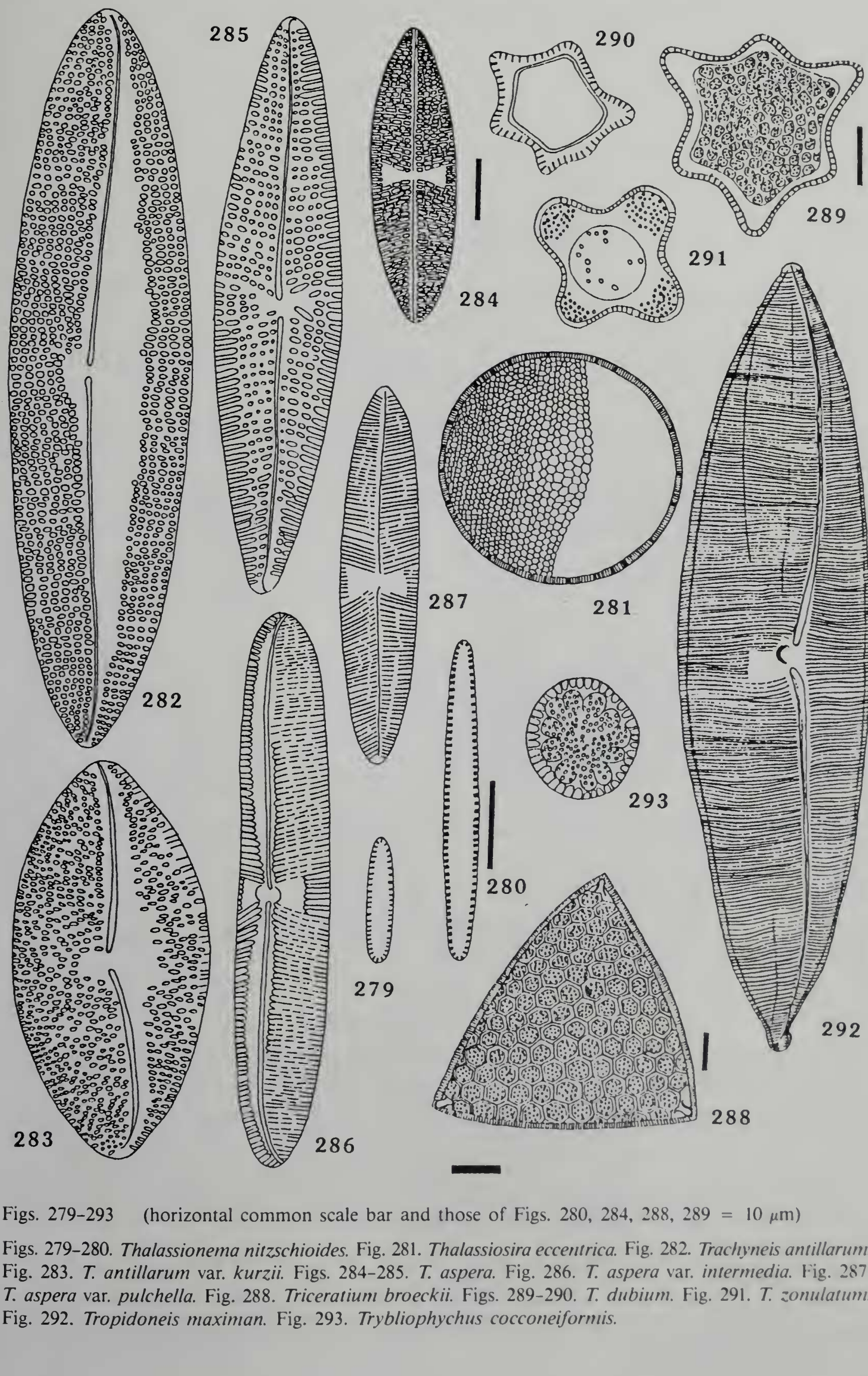
References: Cleve 1894–95, 26(2) p. 191; Hendey 1970, p. 148, fig. 52.
Description: Length 50–126 μm, breadth 14–28 μm, 9–14 striae in 10 μm.
Distribution: Common. Found on slides 2, 12, 116, 333, 335, 343, 347, 350.
Comments: A cosmopolitan species.

T. aspera var. *intermedia* (Grun.) Cl. Fig. 286

References: Cleve 1894–95, 26(2) p. 192; Hendey 1964, p. 237.
Description: Length 111–182 μm, breadth 18–24 μm, 6–9 striae in 10 μm.
Distribution: Not common. Found on slides 100, 350.

T. aspera var. *pulchella* W. Sm. Fig. 287

References: Cleve 1894–95, 26(2) p. 191.
Description: Length 64–120 μm, breadth 17–22 μm, 11–12 striae in 10 μm.



Figs. 279–293 (horizontal common scale bar and those of Figs. 280, 284, 288, 289 = 10 μm)

Figs. 279–280. *Thalassionema nitzschioides.* Fig. 281. *Thalassiosira eccentrica.* Fig. 282. *Trachyneis antillarum.* Fig. 283. *T. antillarum* var. *kurzii.* Figs. 284–285. *T. aspera.* Fig. 286. *T. aspera* var. *intermedia.* Fig. 287. *T. aspera* var. *pulchella.* Fig. 288. *Triceratium broeckii.* Figs. 289–290. *T. dubium.* Fig. 291. *T. zonulatum.* Fig. 292. *Tropidoneis maximan.* Fig. 293. *Trybliophychus cocconeiformis.*

Distribution: Not common. Found on slides 116, 125, 175.
Comments: A cosmopolitan species.

Triceratium Ehrenb. 1841

T. broeckii Leud.-Fortm. Fig. 288

References: Hustedt 1930, 7(1), p. 802, fig. 465; Hendey 1970, p. 118.
Description: Length of side 66–74 μm.
Distribution: Common. Found on slides 3, 116, 351.
Comments: A cosmopolitan species (?).

T. dubium Brightw. Figs. 289–290

References: Boyer 1926–27, p. 128; Hustedt 1930, 7(1), p. 806, fig. 285.
Description: Length of diagonal 33 μm.
Distribution: Common. Found on slides 3, 79, 80, 81, 116, 323, 355, 359.
Comments: A cosmopolitan species.

T. zonulatum Grev. Fig. 291

References: Foged 1975, p. 57, pl. 2, figs. 5, 6.
Description: Length of diagonal 34 μm.
Distribution: Rare. Found on slide 120.

Tropidoneis Cl. 1891

T. maximan (Greg.) Cl. Fig. 292

References: Cleve 1894–95, p. 26; Hendey 1964, p. 256.
Description: Length 166 μm, breadth 38 μm, 11–12 striae in 10 μm.
Distribution: Rare. Found on slide 124.
Comments: A cosmopolitan (?) species.

Trybliophychus Hendey 1958

T. cocconeiformis (Cl.) Hend. Fig. 293

References: Hendey 1958, p. 46, pl. 2, fig. 10.
Description: Length 25 μm, breadth 22 μm, 8 puncta in 10 μm.
Distribution: Rare. Found on slides 116, 347.

Acknowledgements

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Distinguished by the relatively small, ovoid fruits with long, slender pedicels and the broad adult leaves.

Trees not in flowering or fruiting condition are difficult to distinguish from the often sympatric *C. foelscheana* in the field in the Northern Territory, but readily distinguishable from the also sympatric vicariant relatives of *C. foelscheana* in the Kimberley region (*C. curtipes* and *C. greeniana*) on the basis of leaf-shape. There are no similar sympatric species in Queensland or in Papua New Guinea.

Locally often a dominant species on low-lying areas or heavier soils in wetter parts of the Northern Territory (north of Katherine), and the north-western Kimberley region of Western Australia (Fig. 61). Also sporadically present in the Western Province of Papua New Guinea and on the Torres Strait islands offshore from Cape York, Queensland, but apparently rare and localised in these regions. *C. latifolia* may well be present, like *C. novoguinensis* (q.v.), on the Irian Jaya side of the border with Papua New Guinea.

The disjunct distribution and the partial sympatry with several other members of the subseries, as well as the morphological differences, would indicate that *C. latifolia* diverged earlier and is not as close to any of the other species in the group as they are to each other. The remaining species, but not *C. latifolia*, can be grouped as Superspecies *Foelscheana* (Appendix 3).

Hybrids with *C. byrnesii* and *C. oocarpa* are known (see Appendix 1). The types of *E. tokwa* D.J. Carr & S.G.M. Carr and *E. urnularis* D.J. Carr & S.G.M. Carr represent hybrids with *C. novoguinensis* and *C. dichromophloia* respectively (see excluded names and Appendix 1).

Conservation status: Widespread and locally abundant, this species is not considered to be at risk.

Selected specimens (from 85 examined): Western Australia: upper Moran River, near Mt Hann, *Gardner 1448*, 30 June 1921 (PERTH, NSW); 45.5 km from Kalumburu road on Mitchell Plateau road, *Hill 965, Johnson & Benson*, 26 July 1984 (NSW); Cape Bougainville, *Keighery*, 7 June 1988 (PERTH, NSW 301218); 51.7 km N of Wyndham turnoff on Gibb River to Kalumburu road, *Hill 3389, Johnson & Stanberg*, 19 Nov 1988 (NSW); c. 1.6 km NE of Kalumburu, *Johnson 2042*, 23 Aug 1967 (NSW); 13.4 km E of turn-off to N on King George River track (14°09'S 127°17'E), *Brooker 7770*, 1 Nov 1982 (CANB, NSW); 28.4 km from King George River crossing on mining track to south, *Hill 4093 & Stanberg*, 17 Sep 1991 (NSW, CANB, PERTH).

Northern Territory: road between Pickertaramoor and 3-ways, Melville Island, *Brooker 3170*, 23 June 1971 (CANB, NSW); Blyth River crossing on Ramingining to Maningrida road, *Hill 3991 A & Stanberg*, 1 Sep 1991 (NSW, CANB, DNA); Nabarlek, *Hinz R 89*, 5 Dec 1988 (DNA, BRI, CANB, K, MEL, MO, MEL, NSW); Parkinsons Pass, 8.4 km W of Mandorah road on Finnis River road, *Hill 3339, 3340, Johnson & Stanberg*, 16 Nov 1988 (NSW, CANB, DNA); Mitchell Ranges (12°45'S 135°33'E), *Latz 2947*, 23 June 1972 (DNA, NSW); Koolpin Gorge track, *Bowman 126*, 21 Oct 1984 (DNA, NSW); 12 km W of Pine Creek, *Hinz 600*, 15 Sep 1989 (DNA, NSW); 52.2 km E of Ramingining turnoff on Gove road, *Hill 3924 & Stanberg*, 25 Aug 1991 (NSW, CANB, DNA); 8 miles [13 km] NE of Mainoru, *Carolin 9413*, 25 May 1974 (NSW); Edith River Falls road, *Maconochie 1613*, 3 July 1972 (DNA, NSW); 4.2 miles [6.7 km] S of Katherine, *Lazarides 6612*, 6 July 1961 (CANB, NSW); between Bull Oak & Crescent Lagoon, *Spencer*, July–Aug 1911 (NSW 301254); 55 miles [88 km] SW of Dorisvale station, *Perry 2826*, 21 May 1952 (CANB, NSW); 98.0 km from Stuart Hwy on Roper Hwy, *Hill 4122 & Stanberg*, 25 Sep 1991 (NSW, CANB, DNA).

Queensland: Big Creek, Prince of Wales Island, *Cameron 20325*, 9 Feb 1975 (QRS, CANB).

Papua New Guinea: near Weam, Western District (8°38'S 141°07'E), *Ridsdale NGF 33571*, 1 Aug 1967 (LAE, A, BISH, BOG, BRI, CANB, K, L, NSW, SING); about 3 miles [5 km] E of Tokwa, *Henty NGF 49690 & D. Carr*, 13 June 1973 (LAE, A, BRI, CANB, K, L, NSW, US).

Additions to the Flora of Singapore, I

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Abstract

From field and hebarium studies, two new fern and 23 angiosperm taxa were found to have been previously overlooked or newly discovered in Singapore. Brief notes on their description, distribution and collecting localities are made for each.

Introduction

A comprehensive list of vascular plant species has been compiled for Singapore (Turner *et al.*, 1990) from literature and herbarium work. In the course of field work and examination of specimens at the Herbarium, Singapore Botanic Gardens (SING) and the Herbarium, Department of Botany, National University of Singapore (SINU), new records of species were made. Voucher specimens for each newly discovered taxon have been deposited in SINU and/or SING.

New Records

Adiantaceae

1. *Adiantum fructuosum* Spreng.

A large ornamental fern with bipinnate fronds which can grow up to 100 cm long. It originates from the rainforest of tropical America where it is found from Mexico and the West Indies, southern Peru and Brazil. It appears to be naturalized in Singapore and occurs on shaded earth banks along Seton Close and Cluny Road. Here, the plants are about 40 cm tall and freely fertile. (Specimen — Y.C. Wee 451)

2. *Adiantum latifolium* Lam.

A tropical American fern, occurring naturally from Mexico to South America, as well as the Greater Antilles, Virgin Islands and Trinidad. It was introduced into the country as an ornamental during the last ten years and has now established itself in shaded earth banks or flat ground in rural areas. It has also been observed around the southern periphery of the Bukit Timah Nature Reserve and Pulau Ubin. (Specimens — M.Y. Kok 32; Y.C. Wee 452)

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Acanthaceae

1. *Hemigraphis primulaefolia* (Nees) Fern.-Vill.

This species was first collected in Singapore in 1950 by J. Sinclair outside the Botanic Gardens at Cluny Road. A native of the Philippines and Moluccas, it was probably introduced as an ornamental as it is an attractive plant with lilac corollas and leaves, dark jade green above and reddish purple below. It has since spread from the Gardens and can also be seen in many areas in the National University of Singapore campus grounds at Kent Ridge. (Specimens — J. Sinclair S.F. No. 38918; Ali bin Ibrahim AI 46; K.S. Chua and H.T.W. Tan 312; E.M. Sim & L.P. Ng 39)

Asclepiadaceae

1. *Secamone elliptica* R.Br. (*S. micrantha* (Decne.) Decne.)

A slender, twining climber with opposite, chartaceous, narrowly elliptic or lanceolate leaves. Flowers are tiny in short-peduncled or sessile cymes and pale yellow, each producing two spreading, terete, narrow and elongated follicles. This species has been found in the Sungei Buloh area at the fringes of prawn ponds. Its natural range includes Malesia, New Guinea, northern and eastern tropical to subtropical Australia and New Caledonia (Forster and Harold, 1989). (Specimen — K.S. Chua, H.T.W. Tan & M.F. Choong 758)

Balsaminaceae

1. *Hydrocera triflora* (L.) Wight & Arnott

Hydrocera is a monotypic genus which ranges from South India, Sri Lanka, Hainan, Thailand, Cambodia, Laos, the Malaysian Peninsula, South West Celebes and Java (Grey-Wilson, 1980). The species is an erect, aquatic herb with angular and hollow stems which are sometimes floating. Its red flowers are fairly similar to the commonly cultivated balsam (*Impatiens balsamina* L.) but differs from the latter by having five free sepals and five free petals instead of three sepals and having four petals fused into two pairs. The fruit of *H. triflora* is also a five-seeded, indehiscent berry and that of *I. balsamina*, a many-seeded, explosively dehiscent capsule. It is quite common along the shores of Seletar Reservoir. (Specimens — Ali bin Ibrahim AI 139; K.S. Chua, H.T.W. Tan & I.M. Turner 742)

Cannaceae

1. *Canna indica* L.

A stout, perennial herb with more or less erect, glaucous leaves and a creeping and branching rhizome which accounts for its gregarious habit. The flowers have bright red tepals and the fruit is a bristly, globose capsule. It is commonly found in rural areas along roadsides, sides of ditches or drains and even reclaimed land. This species is a native of tropical and sub-tropical America and presumably was introduced here as an ornamental. It has since run wild. (Specimens — K.S. Chua 604; M. Chan 30)

Celastraceae

1. *Maytenus emarginata* (Willd.) D. Hou

A shrub up to 4 m tall. Branches bear short shoots terminated by a spine. Leaves are spirally arranged, obovate to subspathulate with entire to shallowly crenate margins. Flowers are borne in axillary cymes, and white. This species is found behind the beach or mangrove. It ranges from Sri Lanka, South-East Asia to North Queensland, and in Peninsular Malaysia, only recorded from Johor (Hou, 1962). In Singapore, it is found at the back of mangroves near the Kranji Dam. (Specimen — K.S. Chua, H.T.W. Tan, I.M. Turner & J. Yong 792)

Compositae

1. *Porophyllum ruderale* (Jacq.) Cass.

A small, erect, aromatic, weakly branching herb with somewhat fleshy, glaucous leaves. Flowers are in elongated heads up to 2.5 cm long. Plants have been found on reclaimed land or beaches on the mainland and Southern Islands of Singapore. This species is a native of Central and South America. (Specimens — H. Keng 4447; J.F. Maxwell 81-26; K.S. Chua & I.M. Turner 657)

Convolvulaceae

1. *Ipomoea obscura* (L.) Ker-Gawl.

A slender, herbaceous twining or creeping climber which bears ovate to orbicular, cordate leaves. Inflorescences are axillary, one- to few-flowered. The corolla is funnel-shaped, white or yellowish-white with darker midpetalline bands and a dark purple centre. In Singapore, *I. obscura* is found in wasteland or fringes of secondary forest. This species ranges from eastern tropical Africa, Mascarene Islands, tropical Asia, throughout Malesia to Northern Australia and Fiji (van Ooststroom, 1953). (Specimen — K.S. Chua 633)

2. *Ipomoea pes-tigridis* L.

A lacticiferous, twining, sometimes prostrate, herbaceous annual climber, with pure white, funnel-shaped corollas and 5–7 lobed, palmate leaves. This is rare in Singapore, having been collected only twice before; in 1933 by Z. Teruya and in 1941 by E.J.H. Corner. It is a weed and was collected in wasteland on all three occasions. The species ranges from tropical East Africa, Mascarene Islands, continental tropical Asia, and throughout Malesia (van Ooststroom, 1953). (Specimens — Z. Teruya 2332; E.J.H. Corner, s.n. 4 Aug 1991; K.S. Chua 303)

3. *Neuropeltis racemosa* Wall.

This is a large woody climber and was first collected in Singapore by N. Wallich (Ridley, 1923). Keng (1990) doubted the occurrence and noted that this species was "doubtfully recorded in Singapore." Recently, capsules and bracts of this species were collected from the forest floor at Bukit Timah Nature Reserve and confirmed Ridley's observation. It also occurs in Hainan, Thailand and Borneo (van Oostroom, 1953). (Specimen — Ali bin Ibrahim AI 138)

Dipterocarpaceae

1. *Dipterocarpus sublamellatus* F.W. Foxworthy

This is an overlooked species and previous collections were made by H.N. Ridley on Pulau Ubin in 1890 and J. Sinclair at MacRitchie Reservoir on 22 Feb 1957 from a "70 ft. high" tree. Ashton (1982) indicated that this species occurs in Peninsular Malaysia, Sumatra and Borneo but there are no previous records that it occurs in Singapore. (Specimens — H.N. Ridley s.n. 1890; J. Sinclair S.F. No. 8916)

Gramineae

1. *Pennisetum polystachyon* (L.) Schult. (*P. setosum* (Sw.) Rich.)

A tufted and erect plant, up to 2 m tall. The inflorescence, a spike-like panicle, is terminal, golden brown, somewhat lax and nodding. In habit, this species closely resembles *P. purpureum* Schumach. but the latter is a much larger plant, often reaching 5–6 m in height. Also the apex of the anther cells of *P. purpureum* is bearded, whereas in *P. polystachyon* they are glabrous. This species was previously cultivated in the Botanic Gardens (C.X. Furtado s.n. 10 Apr 1929; Md. Nur. s.n. 26 Oct 1929), presumably escaped and now occurs frequently in open wasteland. (Specimen – K.S. Chua 624; Roslina 16)

2. *Setaria barbata* (Lam.) Kunth

An overlooked species, this was first collected by Mahmud Awang in 1971 and more recently collected along Cluny Road and Lorong Gambas. This species is widely distributed from tropical Asia to Africa. (Specimens – Mahmud Awang s.n., 29 Dec 1971; K.S. Chua 329; K.S. Chua 397)

3. *Thysanolaena latifolia* (Roxb. ex Hornem.) Honda

A strongly tufted perennial with erect or slightly spreading culms. This massive reed-like grass has solid culms and bamboo-like leaf blades that are very broad and shortly stalked. The inflorescence is a large open panicle with literally thousands of spikelets which are tiny and gaping with long, silky, spreading hairs.

The tribe Thysanolaeneae is monotypic and occurs in tropical Asia. Gilliland (1971) indicated that *T. latifolia* is cultivated in Singapore but has now escaped and been sighted in the Bukit Timah Nature Reserve, the Central Catchment Area and Pulau Ubin. (Specimens – K.S. Chua 617; A. Ho & E.M. Sim 19)

Leguminosae

1. *Aeschynomene americana* L.

An erect, semi-woody, weakly branched herb which bears pinnate leaves. The papilionaceous flowers are borne in racemes and are mostly yellow. The legumes are mostly curved, jointed and incised on one side. This is a native of tropical America and used as forage crop. It appears to have become naturalized in Singapore. It is commonly found in reclaimed or wasteland. (Specimens – A. Santiago 4413; K. Jumali s.n. 15 Jan 1978; K.S. Chua & H.T.W. Tan 452; K.S. Chua & I.M. Turner 667)

2. *Desmanthus virgatus* (L.) Willd.

A member of the subfamily Mimosoideae, it is also a new generic record for Singapore. The plant is an erect, semi-woody plant with pinnate leaves. Flowers are in globose heads with white petals, stamens and styles. This species is native to tropical America and appears to be fairly well established in reclaimed land. (Specimen – K.S. Chua & H.T.W. Tan 416)

Loranthaceae

1. *Scurrula parasitica* L. (*S. fusca* (Blume) G. Don)

A shrubby, semi-woody, semi-parasite, bearing elliptic to oblong, decussate leaves. Flowers are in racemes, hairy and reddish brown. This species is similar to the much more common *S. ferruginea* (W. Jack) Danser but differs from the latter by its more glabrous abaxial lamina surface (completely red-brown hairy in *S. ferruginea*) and yellowish fruit pulp (greenish in *S. ferruginea*). It has been found only in Pulau Ubin in one location, growing on *Mangifera foetida*. It is distributed in tropical South-east Asia (Danser, 1938). (Specimen — P.T. Chew & A.S. Chew 46)

Lythraceae

1. *Ammania baccifera* L.

An erect, annual herb with apetalous flowers, densely packed at the axils of the dark green, coriaceous leaves. The plant grows up to about 0.6 m and often, much branched at the base. The leaves are mostly decussate except for the higher ones which are opposite and more or less two-ranked. This species grows in wasteland or wet areas. It is of Asian origin. (Specimen — K.S. Chua & H.T.W. Tan 415)

Pedaliaceae

1. *Sesamum radiatum* Schumach.

This is a hairy, erect annual herb which is strongly scented. The corolla is violet with a white blotch with purple streaks inside the lower lip. This species was collected on 2 Oct 1989 on Pulau Ubin in wasteland and is probably an escape from cultivation or a weed. It has also been sighted in a few other locations on the mainland. It is very similar to *S. orientale* L. which is the source of sesame seed oil and distinguished from the latter by having fruits with rounded or very obtuse apices and lower leaves which are simple and neither deeply lobed nor palmately compound. This species is also grown for its oil-containing seeds in its native tropical West Africa. In Malesia, Backer (1951) noted that it is rare, occurring in the Peninsular Malaysia, Sumatra and North Borneo. (Specimen — K.S. Chua & H.T.W Tan 82)

Polygonaceae

1. *Polygonum orientale* L.

An erect, hairy annual bearing flowers with white corollas borne in pseudo-spikes which are arranged in few-branched panicles. This species was collected in 1991 in wasteland off Mandai Road and has become established as a weed. It is native of the old world tropics. (Specimens — Ali bin Ibrahim 136; Ali bin Ibrahim 136A)

Portulacaceae

1. *Talinum paniculatum* (Jacq.) Gaertn.

A semi-erect, fleshy herb which becomes semi-woody especially in the lower parts of the terete stems and branches when older. Leaves are somewhat fleshy, dark green, elliptic to obovate, and spirally arranged. Small flowers bearing pink petals are found in terminal inflorescences. This is a pantropical weed which is native of tropical America (Geesink, 1971). In Singapore, it has been seen in many locations as a weed. (Specimen — M.F. Choong 57)

Rubiaceae

1. *Hedyotis pumila* L.fil. (*Oldenlandia pumila* (L.fil.) DC.)

This species has been seen in various localities and its presence probably depends on dispersal opportunities. Its tiny seeds and viability of up to 72 weeks (Tan and Corlett, 1987) are probably very important for its spread as a weed. It is found in sunny areas including lawns and car parks. It is free-flowering and has a reproductive cycle of three to four months. It was first seen in 1979 in Sian Tuan Avenue then more recently in various other localities since, including Jurong West. Bremekamp (1974) has noted that this species ranges from East Africa to India and has been introduced as a weed in Jamaica. Backer and Bakhuizen van den Brink (1965) also indicated its occurrence in Java. (Specimen — H.T.W. Tan 2/12.12.79)

Typhaceae

1. *Typha angustifolia* L.

A half-submerged freshwater macrophyte that can reach 3 m tall. This robust aquatic has a creeping rhizome and long linear, emergent leaves which are coriaceous. The numerous, tiny flowers are packed into two unisexual spikes. The long and narrow male spike is placed above the sausage-like female spike.

T. angustifolia was accidentally introduced into Singapore in the 1930s. One plant was growing together with a clump of *Cyperus papyrus* which a certain Mr Lee Peck Hoon received from Bangkok. Later he presented it to the Singapore Botanic Gardens, and the clump was planted in one of the lakes. Since then the plant has become naturalized in Singapore. The plants can be found in many stagnant pools or bodies of water in open fields, reclaimed land or construction sites. This species ranges from the arctic circle to 35 °S (Backer, 1951). *T. angustifolia* is the only naturally occurring member of its genus in Malesia. (Specimens — I.H. Burkill s.n., 11 Jul 1932; Md. Nur s.n., 10 Nov 1938; R.E. Holttum s.n., 30 Oct 1941; I.M. Turner 117)

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Fig. 63. *C. pedimontana*. a, adult leaves, inflorescence and buds. b, bud. c, adult leaf, inflorescence and immature fruits. d, e, fruit (all from *Lazarides 6518*). Scale bar: a, c = 3 cm; b, d, e = 1 cm.

between those species and is probably ultimately derived from interbreeding between them. However, it is now self-sustaining and clearly generally stabilised.

The epithet is from Latin *pes, pedis*, a foot, and *mons, montis*, a hill or mountain, and refers to the habitat of the species.

Conservation status: Fairly widespread and locally abundant, this species is not considered to be at risk.

Selected specimens (from 8 examined): Western Australia: Napier Creek, N side of Napier Range, *Brooker 10776*, 23 Apr 1991 (CANB, DNA, NSW, PERTH); Lillimilura Historic Site, Windjana Gorge, *Blaxell 88/024 & Wrigley*, 15 July 1988 (NSW); 10 km W of Tunnel Creek on road to Windjana Gorge, *Blaxell 88/026 & Wrigley*, 15 July 1988 (NSW, PERTH); 58.5 km W of Fitzroy Crossing on hwy, *Blaxell 88/040 & Wrigley*, 16 July 1988 (NSW).

Karyomorphology of Some Myrtaceae from Singapore

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Abstract

Karyomorphology of five species in three genera of Myrtaceae, namely *Callistemon*, *Melaleuca*, and *Syzygium*, is investigated. All five species examined have similar chromosome features at mitotic interphase, prophase, and metaphase. Mitotic metaphase of their somatic cells consistently show $2n=22$, of which 18 chromosomes have centromeres at median position and four at subterminal or terminal position. *Syzygium aromaticum* has a secondary constriction in the longest pair of chromosomes as in several other related and unrelated species of the family, a fact suggesting that the presence of the secondary constriction may be of some taxonomic use.

Introduction

The Myrtaceae consists of about 144 genera and 3,000 species native to tropical and subtropical regions throughout the world (Thorne, 1992). Their infrafamilial relationships are becoming clearer but additional information on systematic characters for detailed study is needed (Johnson and Briggs, 1984). In this paper, we report on the karyomorphology of five species in three genera *Callistemon*, *Melaleuca*, *Syzygium*. The basic chromosome number of the family is $x=11$ (Raven, 1975). However our knowledge on chromosome numbers is still restricted to less than 20 per cent of the species (i.e., some 450 species of 50 genera) largely on the basis of species from Australia and India (Smith-White, 1942, 1948, 1950, 1954; Atchison, 1947; Rye, 1979). Very little information is available on chromosome morphology at metaphase, and nothing is known concerning chromosome features at interphase and prophase.

Materials and Methods

Five species in three genera *Callistemon citrinus*, *Melaleuca cajuputi*, *M. genistifolia*, *M. dealbata*, and *Syzygium aromaticum*[1] (= *Eugenia caryophyllus* [Sprengel] Bullock

[1]Fourty species of "*Eugenia*", all or most of which have synonyms under the generic name *Syzygium*, are reported from Singapore (Keng, 1990). Morphologically and anatomically, a primarily Old World genus *Syzygium* is now clearly distinguished from (Schmid, 1972; Tobe and Raven, 1983), and may even be distantly related to (Johnson and Briggs, 1984), *Eugenia* which is a primarily New World genus. Therefore we adopt *Syzygium aromaticuum*, a synonym under *Syzygium* of "*Eugenia caryophyllus.*" According to Bullock and Harrison (1958), "*Eugenia caryophyllata* Thunb.," a name used occasionally in other studies (Vijayakumar and Subramanian, 1985), is an illegitimate name.

& Harrison; *Eugenia caryophyllata* Thunb.) were investigated in this study. The data collected is presented in Table 1 along with their chromosome numbers. Somatic chromosomes were examined following methods presented elsewhere (Tanaka and Oginuma, 1986). Chromosome numbers and morphology at metaphase were determined using at least three to five cells of young leaves for each collection.

Table 1
Studied taxa, and their collections and chromosome numbers.
Vouchers are preserved at KYO.

Species	Collection	Chromosome number
Callistemon citrinus Skeels	*Oginuma 9101*	$2n=22$
Melaleuca cajuputi Powell	*Oginuma 9103*	$2n=22$
M. genistifolia Sm.	*Oginuma 9104*	$2n=22$
M. dealbata S.T. Blake	*Oginuma & Lum 9201*	$2n=22$
Syzygium aromaticum (L.) Merr. & Perry	*Oginuma 9102*	$2n=22$

Observations

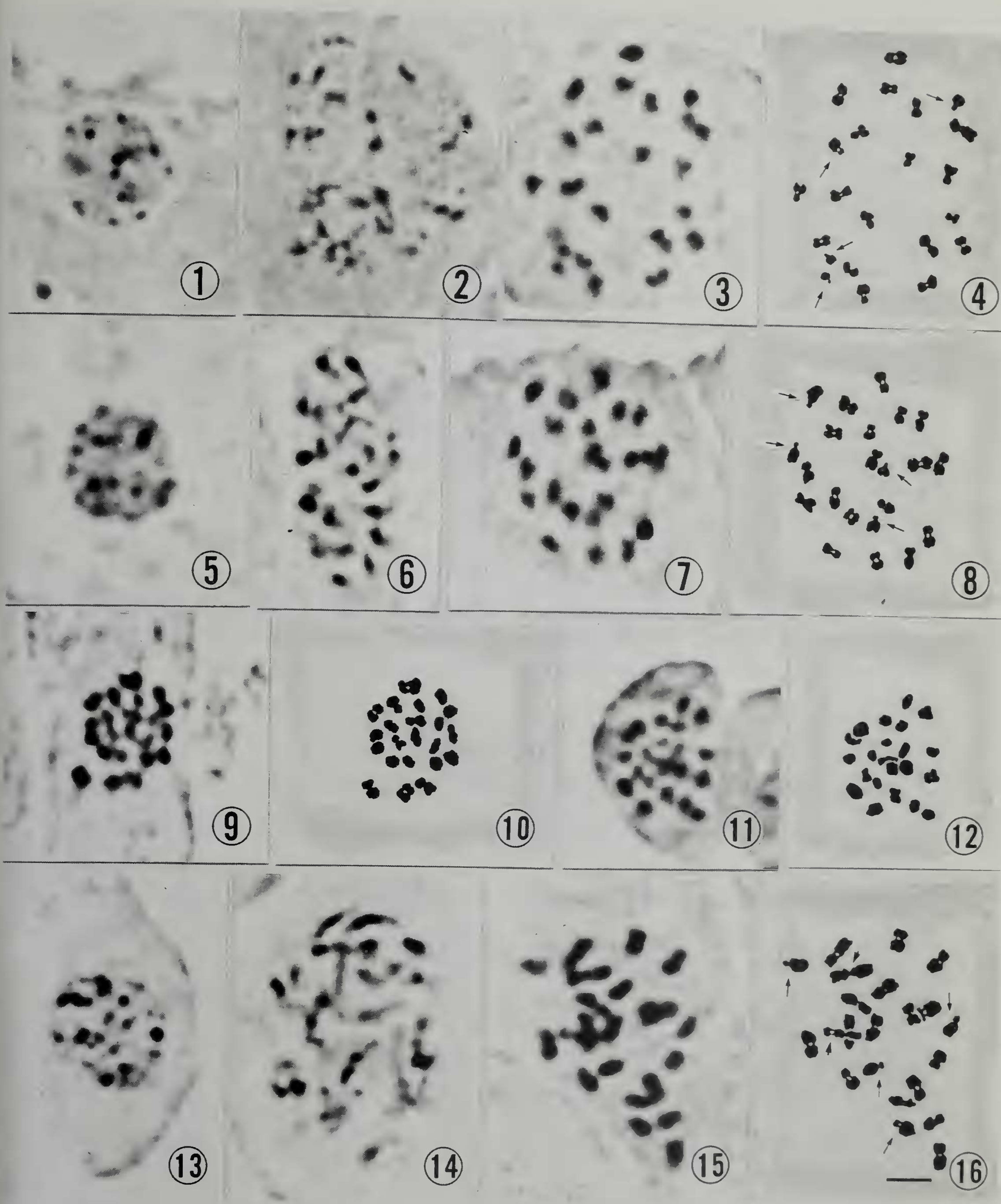
We reconfirmed the earlier report of $2n=22$ in *Callistemon citrinus* (Figs. 1–4) and *Syzygium aromaticum* (Fig. 13–16) (Smith-White, 1948; Vijayakumar and Subramanian, 1985), and further observed $2n=22$ in *Melaleuca cajuputi* (Figs. 5–8) and *M. genistifolia* (Figs. 9–10) (Brighton and Ferguson, 1976; Moussel, 1965).

Chromosomal features at both interphase and prophase are similar in all the species examined. The interphase nucleus (Figs. 1, 5, 13) has 16–20 dark-stained, condensed (heterochromatin) blocks along with chromatin threads and chromomeric granules. As such condensed blocks are fewer than the chromosome number, the nucleus is assigned to the "simple chromocenter type" as defined by Tanaka (1971, 1980). Chromosomes at prophase are differentiated by the presence of both early and late condensed segments (Figs. 2, 6, 14). In most chromosomes the early condensed segments are confined to the proximal regions of two arms, showing a clear transitional state into late condensed segments.

Chromosomes at metaphase are small and gradually vary in a range from about 1.8 μm. to about 0.3 μm. In all the species examined, except in *Melaleuca dealbata* and *M. genistifolia* whose detailed chromosome morphology are not studied, 18 of 22 chromosomes have centromeres at median position, and the remaining four at subterminal or terminal position. A secondary constriction is observed only at the proximal region of a long arm of the longest pair of chromosomes of *Syzygium aromaticum* but not in any chromosome of the other species examined. Satellite chromosomes are not observed.

Discussion

Chromosomal features are nearly consistent in all the five species of *Callistemon*, *Melaleuca*, and *Syzygium* examined. Interphase nuclei belong to the "simple chromocenter type," and chromosomes at metaphase are $2n=22$ ($x=11$) in agreement with most earlier reports on chromosome numbers of these genera. The morphology of



Figs. 1–16. Somatic chromosomes at interphase nucleus (1, 5, 13), prophase (2, 6, 14), and metaphase (3, 4, 7–21, 15, 16) in Myrtaceae. 1–4. *Callistemon citrinus* ($2n=22$). 5–8. *Melaleuca cajuputi* ($2n=22$). 9, 10. *M. genistifolia* ($2n=22$). 11, 12. *M dealbata* ($2n=22$). 13–16. *Syzygium aromaticum* ($2n=22$). Arrows point out chromosomes with centromeres at subterminal or terminal position. Arrowheads point out chromosomes with secondary constriction. Figures 4, 8, 10, 12 and 16 are drawings of respective preceding photographs. Scale = 2μm.

chromosomes at metaphase are also similar: that is, 18 of 22 chromosomes have centromeres at median position, and the remaining four at subterminal or terminal positions. The frequency of chromosomes having centromeres at subterminal or terminal position is consistently 18 per cent in the five species examined, in constrast with a higher frequency of 36 per cent in *Callistemon lanceolatus* and 36–45 per cent in three species of *Syzygium* (including *S. aromaticuum* [= *Eugenia caryophyllata* Thunb.]) (Viyayakumar and Subramanian, 1985). Such a difference in the chromosome morphology between this and the earlier observation needs confirmation in more careful observations in future studies.

Despite consistent chromosome numbers $2n=22$ in the five species of *Callistemon, Melaleuca*, and *Syzygium*, a conspicuous difference is found among them in the presence or absence of secondary constriction at the long arm of the longest chromosomes. Such a secondary constriction is found in *Syzygium aromaticum* but not in the remainder. This feature is also known in a few other related and unrelated species such as *Rhodomyrtus tomentosa*, *Syzygium iambolanum*, and *Eucalyptus citriodora*, which all have $2n=22$ (Vijayakumar and Subramanian, 1985). The presence of the secondary constriction in such species suggests that it may be useful in considering species or generic relationships.

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Fig. 66. *C. ferruginea* subsp. *ferruginea*. a, inflorescence, buds, flowers and adult leaves. b, buds. c, fruits (a from *Brock 60*, b, c from *Telford 8262 & Wrigley*). *C. ferruginea* subsp. *stypophylla*. d, inflorescence, buds and adult leaves. e, buds. f, fruits (from *Brooker 4248*). Scale bar: a, d = 5 cm; b, c, e, f = 2 cm.

59B. ACIXAEK **Corymbia ferruginea** *(Schauer) K.D. Hill & L.A.S. Johnson* subsp. **stypophylla** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Folia adulta minora quam eis subspeciei *ferrugineae*, late lanceolata vel elliptica. Petioli saepissime plus quam 12 mm longi.

Type: Western Australia: 89 miles [142 km] by road from King River crossing towards Gibb River, *M.I.H. Brooker 4248*, 31 Oct 1973 (holo NSW; iso CANB, PERTH).

Adult leaves broad-lanceolate to elliptical, 8–15 cm long, 20–40 mm wide; petioles 8–26 mm long. Fig. 66.

Flowering: Jan, Feb.

Distinguished from subsp. *ferruginea* by the smaller, broad-lanceolate to elliptical adult leaves, with petioles more than 12 mm long.

Subspecies *stypophylla* is largely Western Australian, but scattered populations extend east across the northern margin of the Tanami Desert to north of Renner Springs in the Northern Territory (Fig. 65), to the south of the range of subsp. *ferruginea*. The latter, however, occurs in the south-eastern part of the range of the species, as well as the north, although an intergrade (see below) between subsp. *ferruginea* and subsp. *stypophylla* has also been collected in north-western Queensland.

The epithet is from the Greek, *stypos*, a stalk, and *phyllon*, a leaf, in reference to the petiolate adult leaves.

Conservation status: Widespread and locally abundant, this subspecies is not considered to be at risk.

Selected specimens (from 17 examined): Western Australia: Phillips Range, *Dunlop 6033 & Done*, 10 Nov 1981 (DNA, CANB, NSW, PERTH); 5.6 km N of Drysdale River crossing on Kalumburu road, *Hill 4075 & Stanberg*, 14 Sep 1991 (NSW, CANB, PERTH); 54.2 km W of Durack River on Gibb River Road, *Hill 3381, Johnson & Stanberg*, 19 Nov 1988 (NSW); 10 km W of 'Tableland' homestead, *Johnson 2021*, 21 Aug 1967 (NSW); 43.1 km W of Bindoola Creek on Gibb River Road, *Hill 3370, Johnson & Stanberg*, 19 Nov 1988 (NSW); 8.8 km from 'Bedford Downs' homestead towards Lansdowne, *Hill 3471, Johnson & Stanberg*, 25 Nov 1988 (NSW); 16 km W of Kununurra on highway, *Blaxell 88/058 & Wrigley*, 19 July 1988 (NSW).

Northern Territory: 53.7 km E of Nelson Springs turnoff on Buchanan Highway, *Hill 3534 & Stanberg*, 30 Nov 1988 (NSW); 14.5 km S of Borroloola turnoff on Stuart Highway, *Waterhouse & Wannan*, 17 Jan 1981 (UNSW 11436, CANB, DNA, NSW); 50.3 km N of Renner Springs, *Hill 3259, Johnson & Stanberg*, 8 Nov 1988 (NSW).

Intergrading populations: Subsp. *ferruginea* – subsp. *stypophylla*.

Selected specimens (from 9 examined): Western Australia: 3.8 miles [6.1 km] N of Drysdale River on Kalumburu road, *Brooker 4263*, 1 Nov 1973 (CANB, NSW); 17.3 km from King George River crossing on mining track to south, *Hill 4092 & Stanberg*, 17 Sep 1991 (NSW, CANB, PERTH); 14 miles [22 km] SE of Kimberley Research Station, Ord River, *Perry 2932*, 7 July 1952 (CANB, NSW).

Northern Territory: crest of hill 5.4 km W of Timber Creek, *Hill 3354, Johnson & Stanberg*, 18 Nov 1988 (NSW); 'Bullita' station, *Wightman 2699 & Clark*, 10 Feb 1986 (DNA, NSW); 16.2 miles [30 km] N of No. 9 bore, Murranji Stock Route, *Chippendale NT 3861 & Johnson*, 4 Oct 1957 (DNA, NSW); Daly Waters, *White 202*, 23 June 1922 (NSW); 20.2 km E of Mainoru River crossing, *Hill 3910 & Stanberg*, 24 Aug 1991 (NSW, CANB, DNA).

Queensland: between Turnoff Lagoon and Wollogorang, *Jensen 45*, May 1940 (BRI).

60. ACIXAV **Corymbia abbreviata** *(Blakely & Jacobs) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus abbreviata* Blakely & Jacobs in Blakely, Key Eucalypts: 77 (1934).

Type citation: 'Dr. M.R. Jacobs, No. 105, July 1933'.

Type: Northern Territory: about 20 miles along Maranboy road from Katherine, *M.R. Jacobs 105*, 7.1933 (holo NSW; iso BRI, AFSC).

Tree to 6 m, often several-stemmed and of irregular form. *Rhizomes* not recorded. *Bark* persistent throughout, grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* not seen. *Juvenile leaves* not seen. *Intermediate leaves* opposite, setose to bristle-free, ovate, to 15 cm long, to 80 mm wide, subsessile. *Adult leaves* opposite, bristle-free to sparsely setose, slightly discolorous, amphistomatic, broad-lanceolate to ovate or oblong, rounded or apiculate, 7–16 cm long, 30–80 mm wide; *petioles* 0–5 mm long; main lateral veins widely spaced and brochidodromous; *intramarginal vein* distinct, ± looped, within 3 mm of margin; *oil glands* sparse to frequent, superficial. *Umbellasters* 7-flowered; *peduncles* terete, 9–25 mm long, *pedicels* 0–3 mm long. *Mature buds* ovoid to pyriform, dark red, not setose or scurfy, 9–12 mm long, 6–8 mm diam., smooth; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid-urceolate to globular, constricted below top but not flared, smooth, 20–35 mm long, 17–30 mm diam., 4-locular; *disc* 3–6 mm wide. *Seeds* 12–14 mm long including wing. Fig. 67.

Flowering: Erratic, recorded Jan, July, Nov.

Distinguished within the subseries as follows: adult leaves large, non-setose; neotenous venation persistent; buds sessile or very shortly pedicellate; calyptra shortly patelliform; fruits large, sessile or very shortly pedicellate.

C. abbreviata shares with *C. ferruginea* the neotenous venation in adult leaves and the somewhat ferruginous bristle-glands bearing spreading simple hairs, although the bristle-glands are usually absent from adult leaves. The inflorescence is, however, much more condensed, often to an apparently single umbellaster. Umbellasters may also appear to have more than seven flowers as a result of this condensation.

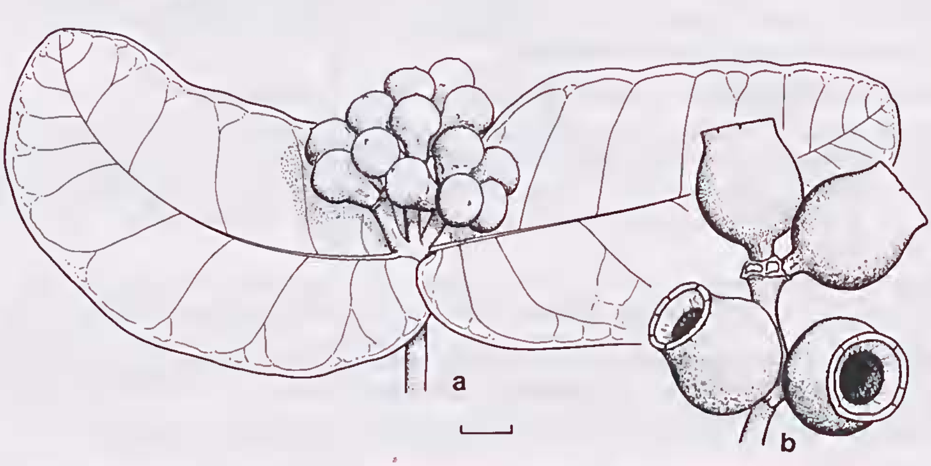

Fig. 67. *C. abbreviata*. a, adult leaves, inflorescence and buds. b, fruits (a from *Perry 2832*, b from *Hill 3300 et al.*). Scale bar = 1 cm.

Scattered and sporadic, from the east Kimberley region in Western Australia to near Katherine in the Northern Territory, on shallow soils on stony rises (Fig. 68). *C. abbreviata* has not been found again around the cited type locality in more recent times, the nearest known occurrence being a considerable distance farther west.

Conservation status: Although scattered and not abundant, this species occurs over a wide area in sites that are unlikely to be threatened, and is not considered to be at risk at the present time.

Selected specimens (from 14 examined): Western Australia: 11.6 miles [18.5 km] from King River crossing on road to Karunjie, *Brooker 4231*, 31 Oct 1973 (CANB, NSW); track from Lake Argyle road into old 'Argyle' homestead, *Hill 926, Johnson & Benson*, 21 July 1984 (NSW).

Northern Territory: 4.1 km from Highway 1 on Duncan Highway, *Hill 3517 & Stanberg*, 29 Nov 1988 (NSW); 'Bullita' station, *Wightman 2644 & Clark*, 8 Feb 1986 (DNA, NSW); near Flora River, 58 miles [93 km] SW of 'Dorisvale' station, *Perry 2832*, 22 May 1952 (CANB, NSW); 102.8 km W of Katherine on highway, *Hill 3300, Johnson & Stanberg*, 11 Nov 1988 (NSW); 29.1 km W of Dorisvale, *Hill 4069 & Stanberg*, 11 Sep 1991 (NSW, CANB, DNA).

ACIXE Subseries **Cadophorosae**

Adult leaves connate, not neotenous; bristle-glands without simple hairs; fruits large.

A unispecific subseries.

61. ACIXEC **Corymbia cadophora** *K.D. Hill & L.A.S. Johnson*, **nom. nov.**

≡ *Eucalyptus perfoliata* R. Br. ex Benth., Fl. Austral. 3: 253 (1867), nom. illegit.; nec Desf., 1829, nom. illegit.; nec Dum.-Cours., 1814, nom. nudum; nec Noisette ex Steud., 1821, nom. nudum; nec Hort. ex G. Don, 1830, nom. nudum; nec Tausch ex Maiden, 1905, pro syn., nom. invalid.; nec A. Cunn. ex Maiden, 1915, pro syn., nom. invalid.

Type citation: 'N. Australia, Barren Hills, Rae's [sic] River, NW. Coast, A. Cunningham; NW. Coast, Bynoe'.

Type: Western Australia: Roe's [Roe] River, *A. Cunningham*, 13 Sep 1820 (lecto K, isolecto BM). Bentham (loc. cit.) cites collections by Cunningham and Bynoe as the 2 syntypes. The Bynoe collection was illustrated by Maiden (Crit. Rev. Eucalyptus 5: plate 180, fig. 1, 1920), but only the Cunningham collection was located by Chippendale (1974). This collection is now designated as lectotype. The Cunningham collection is not the same as the material referred to above, A. Cunn. ex Maiden, 1915 (which refers to specimens of *E. ovata* Labill.).

The homonyms of *E. perfoliata* listed above refer to a number of species. The valid, though illegitimate, publication of *E. perfoliata* Desf., which is a later synonym for *E. globulus* Labill., renders illegitimate the use of the binomial by Bentham. Along with transfer to *Corymbia*, the epithet is here replaced. The new epithet, *cadophora*, derived from the Greek, *kados*, a vase or wine-jar, and *phoros*, bearing, refers to the shape of the fruits.

Tree to 6 m, usually of poor form. *Rhizomes* not recorded. *Bark* persistent throughout, grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* 11–15 mm long, 15–21 mm wide; *petioles* 6–7 mm long. *Juvenile leaves* opposite, setose with bristle-glands and simple hairs, ovate, to 8 cm long, to 40 mm wide, *petioles* 1–3 mm long. *Intermediate leaves* opposite, bristle-free, ovate to oblong, becoming connate after about node 20, to 15 cm long, to 70 mm wide, sessile. *Adult leaves* opposite, weakly discolorous, amphistomatic, bristle-free, grey-green, ovate to oblong, connate, 12–25 cm long, 50–80 mm wide, sessile; venation not neotenous; *intramarginal vein* distinct, within 0.5 mm of margin, or confluent with margin; *oil glands* sparse, superficial. Branchlets pruinose.

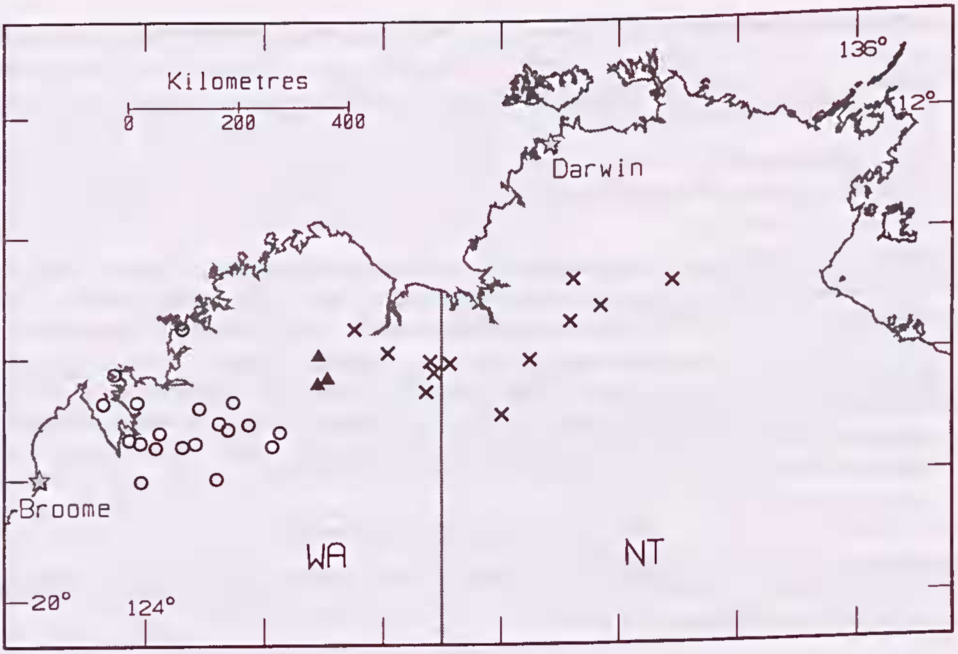

Fig. 68. Distribution of *C. abbreviata* (cross), *C. cadophora* subsp. *cadophora* (circle), *C. cadophora* subsp. *pliantha* (triangle).

Umbellasters 7-flowered; *peduncles* terete or slightly winged, 12–25 mm long, *pedicels* thick, 0–3 mm long. *Mature buds* ovoid or pyriform, not setose or scurfy, 11–18 mm long, 8–10 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemi-spherical. *Fruits* ovoid, sometimes urceolate, distally narrowed or constricted below top, smooth, 22–40 mm diam., 20–30 mm long, 3- or 4-locular; *disc* 3–6 mm wide. *Seeds* 12–15 mm long including wing. Fig. 69.

Flowering: Recorded Aug.

Distinguished within the series by the combination: branchlets pruinose; adult leaves perfoliate (connate in pairs), not neotenously veined; inflorescences regularly extensively branched; buds bristle-free, rounded; calyptra short.

The perfoliate condition of *C. cadophora* is autapomorphic. The basic condition of juvenile leaves in *Corymbia* is petiolate rather than sessile or connate. The earliest juvenile leaves of this species are petiolate; later in the sequence they are sessile, but they remain free for at least 20 nodes. Development of sessile leaves is thus apomorphic, and connation is a further advance. Our observations of several hundreds of individuals in a number of populations in the field indicate that adult leaves are all connate and there is no free stage later in the sequence (see *E. lamprocalyx* under excluded names).

Two geographically separate subspecies are recognised, differing in flower colour and inflorescence branching. Both are confined to the Kimberley region of Western Australia (Fig. 68).

1 Flowers cream; inflorescences sparingly branched (usually less than 10 umbellasters per inflorescence) .... 61A. subsp. **cadophora**

1* Flowers red; inflorescences extensively branched (often more than 10 umbellasters per inflorescence) .... 61B. subsp. **pliantha**

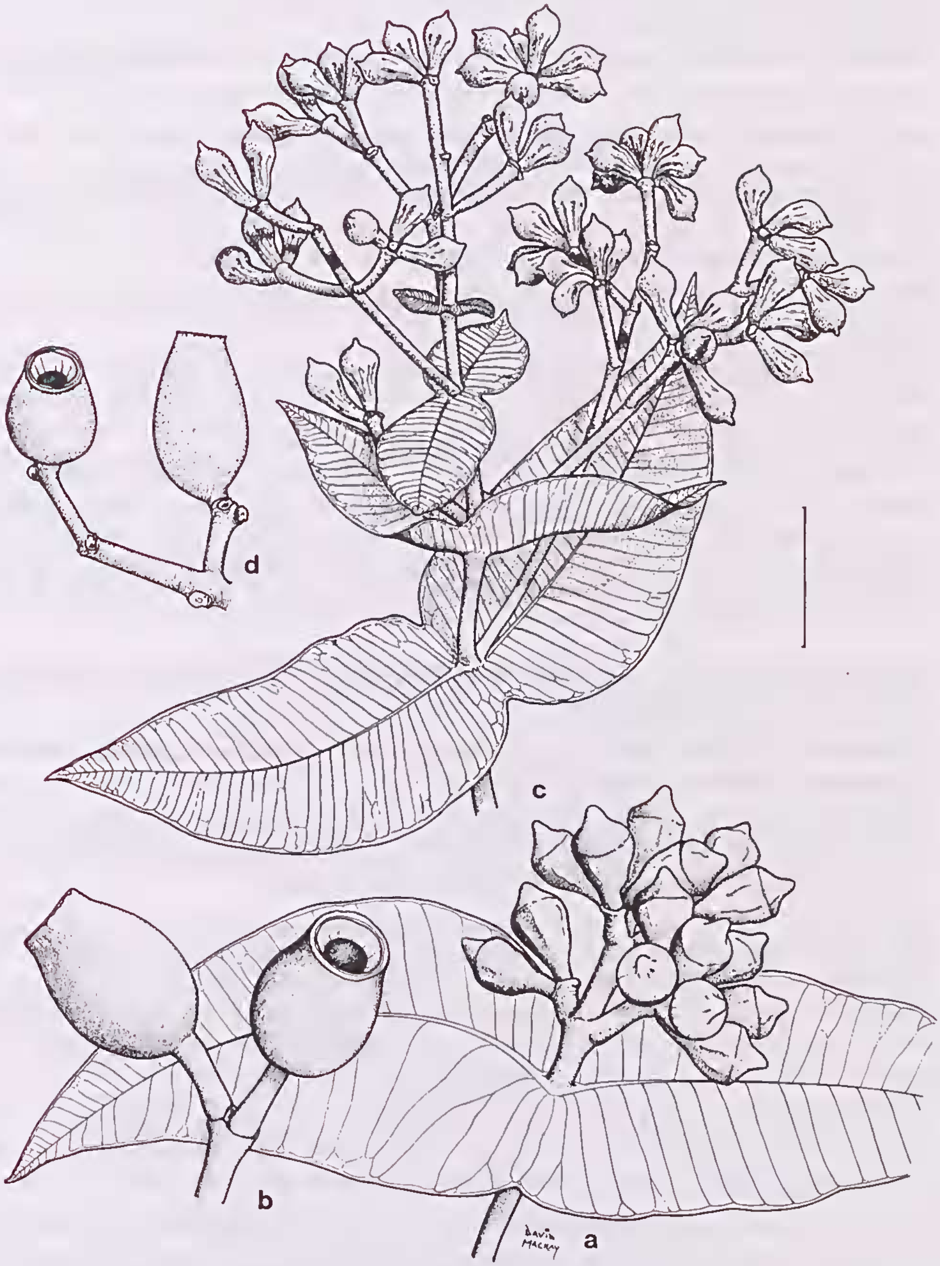

Fig. 69. C. *cadophora* subsp. *cadophora*. a, adult leaves, inflorescence and buds. b, fruits. C. *cadophora* subsp. *pliantha*. c, adult leaves, inflorescence and buds. d, fruits (a, from *Aplin 4686*, b from *Lazarides 6451*, c from *Coate PERTH 2579618*, d from *Brooker 4251*). Scale bar = 2 cm.

61A. ACIXECA **Corymbia cadophora** *K.D. Hill & L.A.S. Johnson* subsp. **cadophora**

Adult leaves 14–25 cm long, 50–80 mm wide. Inflorescence with 1–5 internodes on main axis. *Umbellasters* 7-flowered; *peduncles* terete or slightly winged, 12–25 mm long, *pedicels* thick, 0–3 mm long. *Mature buds* ovoid or pyriform, not setose or scurfy, 13–18 mm long, 8–10 mm diam.. *Fruits* ovoid, sometimes urceolate, apically narrowed or constricted below top, smooth, 22–30 mm diam., 30–42 mm long, 3- or 4-locular; *disc* 3–6 mm wide. Fig. 69.

Hybrids occur with *C. polycarpa*, and have been named *E. lamprocalyx* Blakely, a name also misapplied to *C. cadophora* itself (see excluded names and Appendix 1).

Locally abundant, often dominant in low open shrublands, across the southern Kimberley region from near Derby east and north-east to around Glenroy (Fig. 68). This subspecies occurs on an unusually wide range of substrates, from deep sands with *Triodia* and skeletal soils on sandstones to heavy grey cracking clay-loams on flats or grey clays on basalt or dolerite slopes.

Conservation status: Widespread and locally abundant, this subspecies is not considered to be at risk.

Selected specimens (from 22 examined): Western Australia: Native Well, 9 miles [14 km] from Goody Goody, *Fitzgerald*, Apr 1905 (NSW); 22.6 km NW of Oobagooma homestead on Kimbolton road, *Hill 4111 & Stanberg*, 20 Sep 1991 (NSW, CANB, PERTH); NW end of Grant Range, *Hill 3450, Johnson & Stanberg*, 24 Nov 1988 (NSW); 33 miles NW of Fitzroy Crossing, *Perry 3105*, 17 June 1952 (CANB, B, BRI, DNA, K, MEL, NSW, PERTH, US); gorge to W of 'Silent Grove' homestead, *Hill 3425, Johnson & Stanberg*, 23 Nov 1988 (NSW); 210 km from Derby on road to Fitzroy Crossing, *Aplin 4686*, 16 April 1972 (PERTH, NSW); near Rifle Point, Precipice Range, 25 miles [40 km] SW of 'Mount House' station, *Lazarides 6451*, 28 July 1959 (CANB, NSW); 6 miles [10 km] SE of 'Mount House' station, *Lazarides 5169*, 24 Apr 1955 (CANB, NSW); 45 miles [72 km] W of 'Tableland' station, *Lazarides 6427*, 24 July 1959 (CANB, NSW).

61B. ACIXECI **Corymbia cadophora** *K.D. Hill & L.A.S. Johnson* subsp. **pliantha** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Ab subspecie *cadophora* inflorescentiis ramosioribus, alabastris aliquanto minoribus et filamentis staminum rubris differt.

Type: Western Australia: S [SW] of Kununurra, 199.5 km from junction of Gibb River Road and Great Northern Highway, 1 km S of Campbell Creek, *K. Coate*, 17 June 1992 (holo NSW; iso PERTH 02579618, BRI, DNA).

Adult leaves 12–18 cm long, 40–70 mm wide. Inflorescence with 4–7 internodes on main axis. *Umbellasters* 7-flowered; *peduncles* terete or slightly winged, 12–25 mm long, *pedicels* thick, 0–3 mm long. *Mature buds* ovoid or pyriform, not setose or scurfy, 11–14 mm long, 7–8 mm diam. *Fruits* narrowly ovoid, sometimes urceolate, distally narrowed or constricted below top, smooth, 22–26 mm diam., 25–36 mm long, 3- or 4-locular; *disc* 3–6 mm wide. Fig. 69.

Distinguished from subsp. *cadophora* by the more extensively branched inflorescences with somewhat smaller buds, and by the flowers with red staminal filaments. The fruits are also generally smaller, and adult leaves tend to be smaller.

Subspecies *pliantha* is known at present only from the type locality (Fig. 68). This subspecies is locally abundant, occurring in very open low grassy woodland on skeletal red soil on sandstone slopes, in association with *Eucalyptus (Symphyomyrtus) obconica* Brooker & Kleinig. The labels of the different specimens examined read as though several localities are involved, but this is probably not so.

The epithet is from the Greek *pleios*, more and *anthos*, a flower, referring to the more numerous flowers. Greek *ei* is most traditionally latinised as *i*, thus the spelling is deliberate.

Conservation status: 2K-. Poorly known and not reserved. The particular region has not been fully explored, and more populations may occur.

Selected specimens (from 5 examined): Western Australia: 36.5 km W of Durack River crossing on Gibb River road, *Hill 3377, Johnson & Stanberg*, 19 Nov 1988 (NSW); 110.4 miles by road from the King River crossing west towards the Gibb River Road, *Brooker 4251*, 1 Nov 1973 (CANB, NSW).

ACIXO Subseries **Zygophyllosae**

Adult (and earlier) leaves not connate; simple hairs on bristle-glands not ferruginous; fruits large.

A subseries of 6 species, which group further into three superspecies (Appendix 3), namely (1) Superspecies *Zygophylla*: *C. zygophylla* and *C. sphaerica*; (2) Superspecies *Chartacea*: *C. chartacea* and *C. dunlopiana*; (3) Superspecies *Setosa*: *C. setosa* and *C. pachycarpa*. The subseries epithet is taken from *C. zygophylla* to avoid the awkward *-osos-* that our usual formulation would require if the earlier-described *C. setosa* were used as the base.

62. ACIXOA **Corymbia zygophylla** *(Blakely) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus zygophylla* Blakely, Key Eucalypts: 88(1934).

Type citation: 'W.A. – Broome, W.V. Fitzgerald, April, 1905, and July, 1906, mixed with *E. setosa*. "A low Mallee-like Gum, bark adherent." Strelley River, Prof. J.B. Cleland, 1908'.

Type: Western Australia: Broome, *W.V. Fitzgerald*, May 1905 and July 1906 (lecto NSW). The two cited Fitzgerald collections have been combined, presumably by Blakely (or earlier), and admixed material removed, again presumably by Blakely. Blakely annotated the combined Fitzgerald collection as 'Type' and included the date 'July, 1906'. Blake (1953) then formally accepted the mixed Fitzgerald collection as the lectotype, in contravention of the International Code of Botanical Nomenclature (Articles 9.1, 9.2). Since Blakely intended the Fitzgerald collections to represent the species, the single portion of the collection bearing a fruit is now selected as the lectotype.

Tree to 8 m, usually less than 4 m and of irregular form. *Rhizomes* not recorded. *Bark* persistent throughout, grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* not seen. *Juvenile leaves* not seen. *Intermediate leaves* opposite, setose with bristle-glands bearing some simple hairs, ovate, to 10 cm long, to 60 mm wide, sessile. *Adult leaves* opposite, concolorous, amphistomatic, bristle-free, lanceolate or broad-lanceolate to ovate, acute or acuminate, 6–11 cm long, 20–30 mm wide, sessile; *intramarginal vein* distinct, within 2 mm of margin; *oil glands* sparse to frequent, superficial. Branchlets whitish but not pruinose. *Umbellasters* 3–7-flowered; *peduncles* terete, 7–15 mm long, *pedicels* 0–3 mm long. *Mature buds* pyriform, sometimes setose, not scurfy, 9–12 mm long, 6–8 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid-urceolate, distally narrowed or constricted below top, not flared, smooth but becoming brown-scaly, 20–35 mm long, 20–30 mm diam., 4-locular; *disc* 2–5 mm wide. *Seeds* 10–12 mm long including wing. Fig. 70.

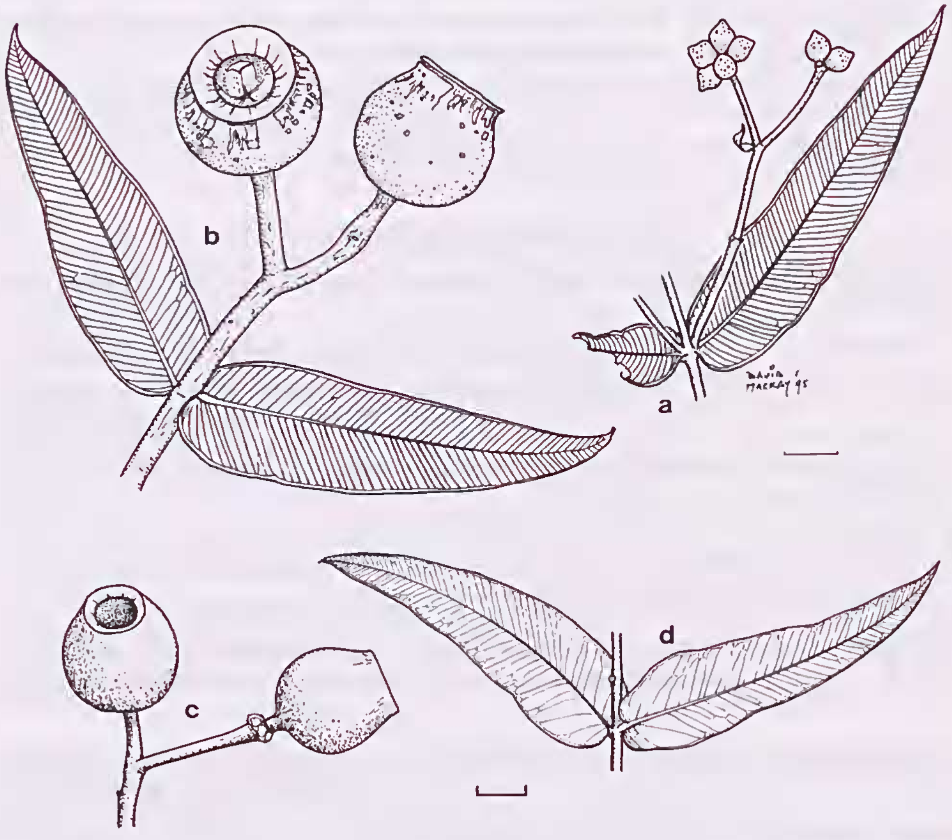

Fig. 70. *C. zygophylla* a, adult leaves and buds. b, adult leaves and fruits. c, fruits. d, adult leaves. (a from Hill 4116 & Stanberg; b from *Blaxell 88/002 & Wrigley*; c, d from *Hill 418 et al.*). Scale bar = 1 cm.

Distinguished within the subseries as follows: adult leaves free, elongate, bristle-free, often falcate; simple trichomes present on bristle-glands; buds rounded, almost bristle-free; calyptra shortly patelliform; fruits sessile, large, eventually scaly.

This species and the related *C. sphaerica* are characterised by the very slender leafy twigs, the bristle-free leaves with fully adult-type venation, and the rounded, almost bristle-free buds with a very short calyptra. As in *C. setosa*, the branchlets have a whitish surface that peels off, but they are not pruinose as in *C. chartacea* and *C. dunlopiana* (and *C. cadophora*).

C. zygophylla is confined to Western Australia, occuring in several disjunct populations around Broome, east almost to Fitzroy Crossing, and from near North West Cape and the coastal plain to the west and north of the Pilbara region, south-easterly to near Exmouth Gulf (Fig. 71). It usually occurs in low open savannah woodland or shrubland, on red sands or sandy red earths.

South-western occurrences more frequently display 7-flowered umbellasters, smaller fruits, and smaller and thicker leaves, although these characters are highly variable.

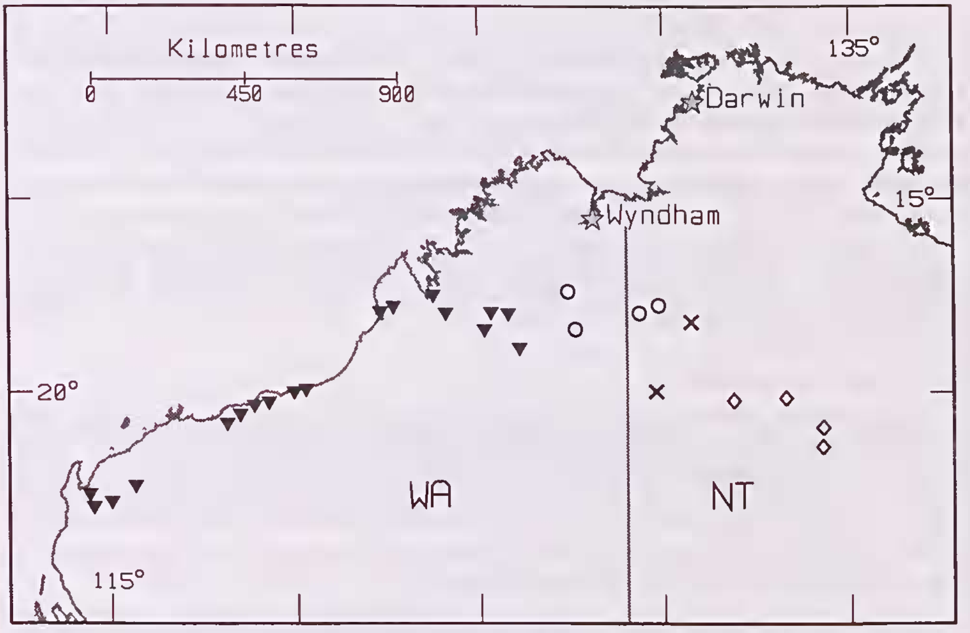

Fig. 71. Distribution of *C. zygophylla* (triangle), *C. sphaerica* (diamond), *C. pachycarpa* subsp. *pachycarpa* (circle), *C. pachycarpa* subsp. *glabrescens* (cross).

Selected specimens (from 27 examined): Western Australia: c. 30 km from Broome on Derby road, *Blaxell 88/002 & Wrigley*, 13 July 1988 (NSW); 16 miles [27 km] NW of 'Liveringa' station, *Perry 3114*, 18 June 1952 (CANB, B, BRI, DNA, K, L, MEL, NSW, US); 100.4 km E of Fitzroy Crossing (at river) on highway, *Hill 4116 & Stanberg*, 22 Sep 1991 (NSW, CANB, PERTH); 'Leopold Downs', *Done 282*, 31 July 1980 (DNA); NW end of Grant Range, *Hill 3451, Johnson & Stanberg*, 24 Nov 1988 (NSW); Broome, *Johnson 2106*, 27 Aug 1967 (NSW); Edgar Ranges survey site D1, *Kenneally 5617*, 12 Aug 1976 (PERTH, CANB); c. 100 km SE of Fitzroy Crossing, *Dunlop 6004 & Done*, 6 Nov 1981 (DNA, BRI, NSW, PERTH).; 44 km ENE of Pardoo Roadhouse on Highway 1, *Johnson 9292 & B. Briggs*, 26 July 1991 (NSW); Strelley River, *Cleland*, 1908 (NSW 10090); Ankatell [Anketell] Ridge, Great Sandy Desert, *Mitchell 1107*, 14 May 1979 (CANB); behind communications centre, Exmouth, *Allan 474*, 7 Sep 1970 (CANB); 8.3 km from Coastal Hwy at Nanutarra towards Paraburdoo, *Brooker 10740*, 17 Apr 1991 (CANB, AD, NSW, PERTH); about 1 km SE of Giralia Homestead, *Hill 418, Johnson, Blaxell & Brooker*, 29 Oct 1983 (NSW, CANB, PERTH); 2.5 km SW of Barradale Roadhouse on Highway 1, *Johnson 9342 & B. Briggs*, 2 Aug 1991 (NSW, CANB, PERTH); 0.5 miles [0.8 km] W of North-west Highway towards Bullara, *Brooker 4566*, 23 Apr 1974 (CANB).

63. ACIXOE **Corymbia sphaerica** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Folia adulta parva, crassa, sine setoglandulis, rotundata. Alabastra globularia vel subglobularia, fere glabra vel setoglandulis brevibus instructa. Calyptra patelliformis, brevissima. Trichomata simplicia praesentia in setoglandulis. Fructus laeves vel denique squamosi, globulares, crassi, sessiles vel in pedicellis brevibus crassisque.

Type: Northern Territory: 3 km N of Lake Surprise (20°12'S 131°48'E), *P.K. Latz 10961*, 21 Oct 1988 (holo NSW; iso CANB, DNA, PERTH).

Tree to 10 m, of irregular form or with a rounded canopy. *Rhizomes* not recorded. *Bark* persistent throughout, brown to grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* not seen.

Juvenile leaves not seen. *Intermediate leaves* opposite, sometimes bristle-free but usually sparsely setose with bristle-glands bearing short simple hairs, ovate to suborbicular, to 8 cm long, to 50 mm wide, sessile. *Adult leaves* opposite, weakly discolorous, amphistomatic, bristle-free, grey-green, ovate to oblong, 4–8 cm long, 15–45 mm wide, sessile; *intramarginal vein* distinct, within 1 mm of margin; *oil glands* sparse to frequent, superficial. Branchlets whitish but not pruinose. *Umbellasters* 7-flowered; *peduncles* terete or slightly winged, 5–30 mm long, *pedicels* thick, 2–7(–12) mm long. *Mature buds* globular or subglobular, often minutely setose on apex, not scurfy, 10–12 mm long, 9–10 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemispherical. *Fruits* globose, narrowed at top, smooth or ultimately scaly, 20–30 mm diam., 20–30 mm long, mostly 4-locular; *disc* 2–5 mm wide. *Seeds* 9–12 mm long including wing. Fig. 72.

Flowering: Not recorded.

Distinguished within the subseries by the combination: adult leaves small, thick, bristle-free, rounded; buds globular or subglobular, sparsely setose with bristle-glands; calyptra patelliform, very short; short simple trichomes present on bristle-glands; fruits bristle-free, globular, thick-walled, sessile or on short, thick pedicels.

Near *C. zygophylla*, differing in broader leaves, longer pedicels and apparently in the fruits remaining non-scaly for a longer period.

C. sphaerica is a restricted species, confined to the Northern Territory and ranging around the north-eastern fringe of the Tanami Desert, from near Lake Surprise to around Barrow Creek (Fig. 71). It occurs in open shrublands with *Triodia* on deep red aeolian sands.

The specific epithet is from the latinised Greek, *sphaericus*, spherical, referring to the globular buds and fruits.

Conservation status: Very poorly collected, but over a wide area, probably not at risk.

Selected specimens (from 17 examined): Northern Territory: 13 miles [20 km] NW of 'Numagalong' homestead, *Nelson & Swinbourne NT 11805*, 26 Aug 1965 (DNA, NSW); 10 km N of Taylor Creek, Stuart Highway, *Thomson 889*, 23 Oct 1985 (DNA, NSW); 2.9 km N of Taylor Creek on Stuart Highway, *Brooker 9970*, 21 June 1988 (CANB, NSW); 42 km N of Barrow Creek on Stuart Highway, *Hill 3251, Johnson & Stanberg*, 8 Nov 1988 (NSW).

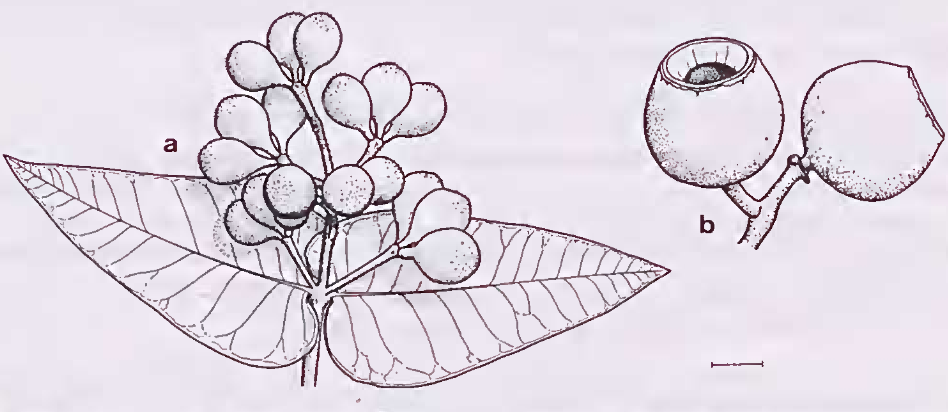

Fig. 72. C. *sphaerica*. a, adult leaves, inflorescence and buds. b, fruits (from *Hill 3251 et al.*). Scale bar = 2cm

64. ACIXOJ **Corymbia** chartacea *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Setoglandulae mediocres, sine trichomatibus simplicibus. Folia adulta magna, tenuia, ad apicem saepe acuta et sensim attenuata. Ramuli pruinosi. Umbellastrae plerumque 7-florae. Flores filamentis albis, non roseis. Fructus magni, urceolati plusminusve ad apicem expansi. Pedicelli breves vel mediocres, crassi.

Type: Northern Territory: 'Ja Ja Camp' [Mudginberry Station, about 12°34'S 132°53'E], *D.F. Blaxell 1816*, 2 Dec 1980 (holo NSW; iso BRI, CANB, DNA)

Tree to 8 m, often with pendulous branches. *Rhizomes* not recorded. *Bark* persistent throughout, brown to grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* 11–12 mm long, 16–18 mm wide; *petioles* 6–7 mm long. *Juvenile leaves* opposite, setose with bristle-glands and bearing simple hairs, ovate, to 3 cm long, to 15 mm wide, *petioles* to 1.5 mm long. *Intermediate leaves* opposite, bristle-free, ovate to oblong, to 12 cm long, to 70 mm wide, sessile. *Adult leaves* opposite, weakly discolorous, amphistomatic, bristle-free, grey-green, ovate to oblong, 6–15 cm long, 30–65 mm wide; *petioles* 0–2 mm long; *intramarginal vein* distinct, within 1 mm of margin; *oil glands* frequent, superficial. Branchlets pruinose. *Umbellasters* 7-flowered; *peduncles* terete or slightly winged, 8–12 mm long, *pedicels* thick, 2–12 mm long. *Mature buds* ovoid or pyriform, shortly setose, not scurfy, 11–16 mm long, 8–11 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemispherical. *Fruits* ovoid-urceolate, constricted well below top, smooth or brown-scaly, 24–30 mm diam., 20–30 mm long, 3- or 4-locular; *disc* 5–8 mm wide. *Seeds* 14–16 mm long including wing. Fig. 73.

Flowering: Recorded Aug.

Distinguished within the subseries by the combination: bristle-glands medium-sized, lacking simple trichomes; leaves large, thin, often apically acute and tapered; branchlets pruinose; umbellasters mostly 7-flowered; flowers white; fruits large, distinctly urceolate; pedicels short to medium, thick.

C. chartacea is a relatively restricted species, confined to the Northern Territory and occurring only in north-western Arnhem Land and the adjacent escarpment country to the west, as far south as Jim Jim Falls (Fig. 74). Locally frequent, mostly on sandy or lateritic soils in flat country, forming communities of small, spreading trees with distinctively pendulous outer branchlets, these sometimes hanging as long streamers. It also occurs as an understorey species in *Eucalyptus (Fibridia) tetrodonta* savannah forests or woodlands.

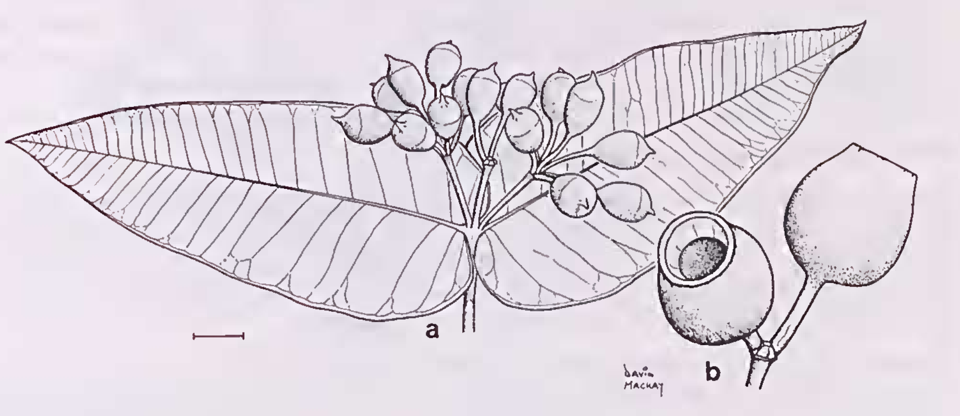

Fig. 73. *C. chartacea*. a, adult leaves, inflorescence and buds. b, fruits (from *Dunlop 4306*). Scale bar = 2 cm.

Leaves are larger, relatively narrower and less setose than those of *C. dunlopiana*, and bristle-glands are usually shorter. The flowers are also white in contrast to the usually pink or red flowers of *C. dunlopiana*.

The epithet is from the Latin *chartaceus*, resembling paper, referring to the leaf-texture. The 'ch' is pronounced as 'k'.

Conservation status: Not considered to be at risk.

Selected specimens (from 21 examined): Northern Territory: Barge Landing, Mountnorris Bay, Murganella [Murgenella], *Wightman 2001*, 10 July 1985 (DNA); S Brogden Point, *Dunlop 4293*, 3 Oct 1976 (DNA, NSW, K); 50 miles [80 km] WNW of Oenpelli Mission, *Latz 3055*, 28 June 1972 (DNA, NSW); 110.2 km from Maningrida to Ramingining road on Oenpelli road (0.9 km W of Goomadeer River crossing), *Hill 4010 & Stanberg*, 1 Sep 1991 (NSW, CANB, DNA); 10 miles [16 km] W of Goomadeer turn, Oenpelli-Maningrida road, *S. Jacobs 1895*, 6 June 1974 (NSW); Oenpelli, *Specht 1151*, 7 Oct 1948 (NSW, CANB); Cannon Hill, *Dunlop 4306*, 1 Nov 1967 (DNA, BRI, CANB, K, NSW); Kapalga ref 1110 [about 12°36'S 132°35'E], *Collins BC59*, 31 July 1976 (DNA); between camp site and Twin Falls, Kakadu National Park, *Boland 2128 & Wardman*, 16 Nov 1984 (NSW, CANB); 46.5 km from Kakadu Highway on Arnhem Highway (W of South Alligator crossing), *Hill 4031 & Stanberg*, 5 Sep 1991 (NSW, CANB, DNA).

65. ACIXOL **Corymbia dunlopiana** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Setoglandulae longae, sine trichomatibus simplicibus. Folia adulta venatione quasi juvenili, magna, tenuia, distaliter rotundata et obtusa vel apiculata. Ramuli pruinosi. Flores saepe filamentis roseis. Fructus magni, urceolati ad summum expansi. Pedicelli mediocres usque ad longissimi, graciliusculi.

Type: Northern Territory: c. 15 km W of Pine Creek on Jindare road [13°56'S 131°44'E]; *C. Dunlop 6772 & G. Wightman*, 6 Mar 1985 (holo NSW; iso CANB, DNA, MEL, RSA).

Tree to 5 m (or perhaps sometimes larger), usually several-stemmed and of irregular form. *Rhizomes* not recorded. *Bark* persistent throughout, brown to grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* to 12 mm long, to 16 mm wide; *petioles* to 7 mm long. *Juvenile leaves* opposite, setose with bristle-glands and bearing simple hairs, ovate, to 5 cm long, to 20 mm wide, *petioles* 0–2 mm long. *Intermediate leaves* opposite, setose with long bristle-glands, ovate, to 8 cm long, 50 mm wide, sessile. *Adult leaves* opposite, weakly discolorous, amphistomatic, setose with long bristle-glands, rarely bristle-free, green, ovate to orbicular, 5.5–9 cm long, 30–55 mm wide, sessile; *intramarginal vein* distinct, within 1 mm of margin; *oil glands* frequent, superficial. Branchlets pruinose. *Umbellasters* 3-flowered; *peduncles* terete or slightly winged, 12–35 mm long, *pedicels* 8–22 mm long. *Mature buds* ovoid or pyriform, setose with long bristle-glands, not scurfy, 15–25 mm long, 10–12 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemispherical. *Fruits* ovoid-urceolate, constricted well below top, then mostly flared, smooth or brown-scaly, 25–35 mm diam., 18–30 mm long, 3- or 4-locular; *disc* 4–7 mm wide. *Seeds* 12–15 mm long including wing. Fig. 75.

Flowering: Irregular, recorded Feb, Apr, Sep, Nov.

Distinguished within the subseries by the combination: bristle-glands long, lacking simple trichomes; adult leaves large, thin, distally rounded and obtuse or apiculate; branchlets pruinose; inflorescences leafy, umbellasters mostly 3-flowered; flowers often with pink filaments; fruits large, urceolate and distinctly flared towards the top; pedicels medium to very long, relatively slender.

The fruits tend to be longer and more strongly flared at the top than those of *C. chartacea*, and leaves are relatively broader, but shorter and more frequently setose. Adult leaves are also consistently neotenous in venation-type, whereas *C. chartacea* usually produces leaves with fully adult venation.

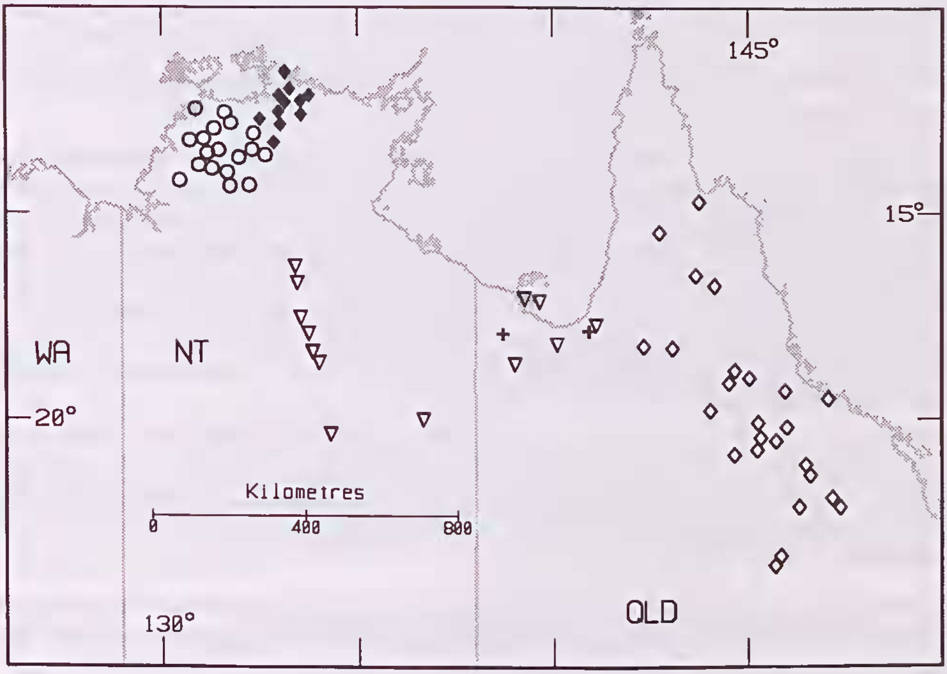

Fig. 74. Distribution of C. *setosa* subsp. *setosa* (triangle), subsp. *pedicellaris* (open diamond), subsp. *setosa* – subsp. *pedicellaris* intergrades (plus), C. *dunlopiana* (circle), C. *chartacea* (solid diamond).

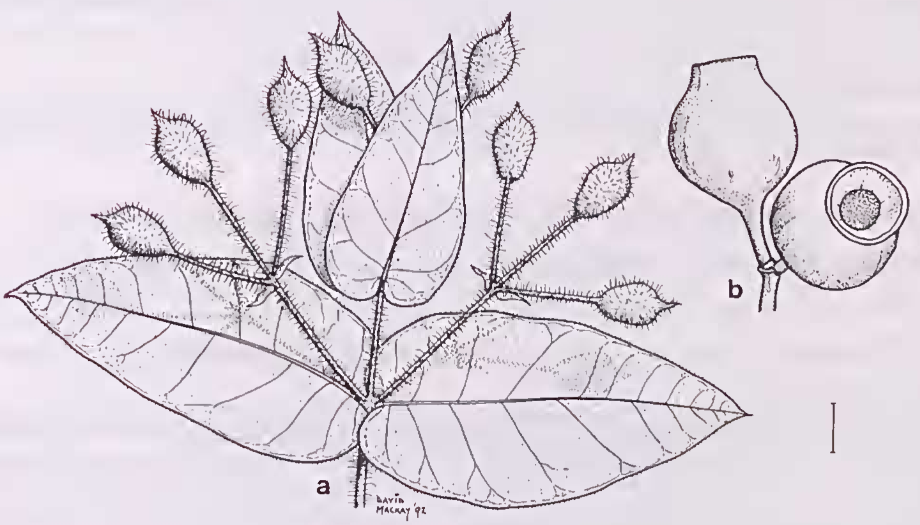

Fig. 75. C. *dunlopiana*. a, adult leaves, inflorescence and buds. b, fruits (from *Benson 973*). Scale bar = 2 cm.

Leaves and fruits of *C. dunlopiana* are quite variable in bristliness, from densely setose to bristle-free within populations. This may be thought to reflect some breakdown with *C. chartacea*, although bristle-free specimens show the pedicel length and leaf-shape of *C. dunlopiana*, and occur wholly within the range of the latter species.

This species and *C. cadophora* subsp. *pliantha* are the only members of the *Ferrugineae* known to have coloured filaments in the flowers.

C. dunlopiana shows the most highly reduced inflorescences within the group, umbellasters frequently appearing single and axillary, sometimes sessile within leaf axils, and occasionally reduced to solitary axillary flowers. Inflorescences are not clearly demarcated from leafy shoots, and lower umbellasters are usually subtended by expanded leaves rather than fugacious bracts as is usual in *Corymbia*. Inflorescences may also be terminated by a flower rather than a suppressed vegetative bud as is more frequently seen in the genus. This could be a plesiomorphic survival of the 'flexible' inflorescence type (Briggs & Johnson 1979), but is perhaps more likely to be a secondary evolutionary reversion.

Scattered across the north-western part of the Northern Territory, from the South Alligator River to the edges of the west coast floodplains, entirely north of 14°30'S (Fig. 74). Locally frequent on skeletal soils on low outcrops of sandstones or siliceous metamorphics, often forming pure stands of small, twisted, frequently several-stemmed, rather shrubby individuals.

The species is named in honour of Clyde R. Dunlop, Senior Botanist at the Northern Territory herbarium (DNA) and a keen observer of the eucalypts of the 'Top End'.

Conservation status: Not considered to be at risk.

Selected specimens (from 49 examined): Northern Territory: Moline road, near Mary River, *Byrnes 2470*, 24 Jan 1972 (NSW, CANB, DNA); 14 km SW of Jim Jim, *Benson 973*, 13 July 1974 (NSW); Bridge Creek, *Burkitt*, 1881 (NSW 305075, MEL); 1.6 km W of South Alligator River, El Sharana road, *Hill 3318, Johnson & Stanberg*, 13 Nov 1988 (NSW); Sleisbeck road, c. 8 km S of Gimbat turnoff, *Dunlop 5212*, 6 Dec 1979 (DNA, NSW); Pine Creek, *Chippendale NT 7589*, 16 Mar 1961 (DNA, NSW); Daly River road, 4 miles [6.4 km] from Mission, *Robinson D 742*, 4 Feb 1964 (DNA); c. 13 miles [21 km] SW of Tipperary homestead, *Lazarides 6644*, 14 July 1961 (CANB, NSW); c. 2 miles [3.2 km] S of Edith River, *Brooker 3138*, 17 June 1971 (CANB, NSW); edge of plain near Emu Point (at 14°12'S 130°26'E), *Hill 4051 & Stanberg*, 10 Sep 1991 (NSW, CANB, DNA); 20 miles [32 km] NE of 'Claravale' station, *Speck 1615*, 22 Aug 1961 (CANB, NSW); 6 miles [10 km] NE of Katherine, *I. Wilson 386*, 7 Mar 1965 (DNA, CANB).

Bristle-free specimens:Northern Territory: 45 miles [72 km] from highway on Daly River road, *Byrnes 1902*, 16 Apr 1970 (DNA); Green Ant Creek, *Byrnes 1803 B*, 6 Mar 1970 (DNA).

66. ACIXOS **Corymbia setosa** *(Schauer) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus setosa* Schauer in Walpers, Rep. Bot. Syst. 2: 926 (1843).

Type citation: 'In Nova Hollandia legit Ferd. Bauer!'

Type: Queensland: Allen Is.[Allen I], *R. Brown & Ferd. Bauer (Bennett 4782)*, [20 Nov 1802] (holo W; iso BM, E, K, NSW).

Maiden (Crit. Rev. Eucalyptus 4, 1919) records the application of the epithet *hispida* to specimens of this species distributed in Europe. Specimens of Bauer's collection (the type) were distributed by J.J. Bennett of the British Museum in 1876 with the label '*E. setosa* Schauer (*hispida* R. Br.)', and a possibly different Bauer collection housed at W is labelled '*E. hispida* Tausch'.

Tree to 20 m, usually much less and of poor form. *Rhizomes* not recorded. *Bark* persistent throughout, brown to grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* 7–12 mm long, 12–17 mm wide; *petioles* 3–6 mm long. *Juvenile leaves* opposite, setose with bristle-glands and bearing simple hairs, ovate, 2–7 cm long, 7–26 mm wide, *petioles* 0–5 mm long. *Intermediate leaves* opposite, setose with bristle-glands and bearing simple hairs, ovate, to 6 cm long, 40 mm wide; *petioles* 0–3 mm long. *Adult leaves* opposite, weakly discolorous, amphistomatic, ± setose with bristle-glands, grey-green, ovate to oblong, 1.5–6 cm long, 10–50 mm wide; *petioles* 0–1 mm long; *intramarginal vein* distinct, within 1 mm of margin; *oil glands* frequent, superficial. Branchlets ± whitish but usually not pruinose. *Umbellasters* 7-flowered; *peduncles* terete or slightly winged, 5–25 mm long, *pedicels* 3–15 mm long. *Mature buds* ovoid or pyriform, usually setose with medium to long bristle-glands, not scurfy, 7–9 mm long, 6–8 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemispherical. *Fruits* ovoid to globose, distally narrower or sometimes constricted below top, smooth or brown-scaly, 13–20 mm long, 13–23 mm diam., 3- or 4-locular; *disc* 2–5 mm wide. *Seeds* 10–13 mm long including wing.

Distinguished within the subseries by the small leaves, the relatively short bristle-glands with some lateral development of short simple trichomes towards the tips, the scurfy, globular, apically narrowed and somewhat urceolate fruits, and the mostly 7-flowered umbellasters.

Widespread from the central Northern Territory to near Barcaldine in central Queensland and north to the Gulf of Carpentaria and the Musgrave district in eastern Cape York Peninsula, but usually occurring in small and scattered patches (Fig. 74). A sometimes stout tree, or mallee-like, growing on residual sands with *Triodia*, stony siliceous or lateritic rises, or on sandy red earths. Fruit size decreases in the east and north.

The fine branchlets in leaf-bearing regions are whitish (but usually not distinctly pruinose), especially in the drier parts of the range. This characteristic is evident to some extent in Superspecies *Zygophylla* also.

Two geographic subspecies are distinguished on the basis of differences in juvenile leaves, indumentum and pedicels.

1 Pedicels mostly less than 7 mm long, juvenile leaves sessile .... 66A. subsp. **setosa**

1* Pedicels mostly more than 7 mm long, juvenile leaves often petiolate .... 66B. subsp. **pedicellaris**

66A. ACIXOSE **Corymbia setosa** *(Schauer) K.D. Hill & L.A.S. Johnson* subsp. **setosa**

Petioles of juvenile leaves 0–1 mm long. Adult leaves 1.5–6 cm long, 12–42 mm wide, sessile. Peduncles 5–15 mm long; pedicels 3–7 mm long. Fruits 17–28 mm long, 15–23 mm diam. Fig. 76.

Flowering: Not recorded.

Distinguished by the medium-sized to large fruits with short pedicels, the relatively shorter bristle-glands with weak development of papilliform simple trichomes, and the sessile juvenile leaves. Adult leaves tend to be less setose than in subsp. *pedicellaris*.

This subspecies occurs through the central eastern Northern Territory, mainly from the north-south highway eastwards, from around Daly Waters to south of Tennant Creek, with somewhat disjunct occurrences in Queensland around Normanton and in the Mornington Island group (Fig. 74).

The Queensland occurrences (which include the holotype) differ slightly from those in the Northern Territory; adult leaves in the former tend to be thinner in texture and more orbicular, and branchlets tend to be less white.

Subspecies *setosa* usually occurs as a small tree, or may be mallee-like on deep red sand with *Triodia*, or on sandstone or lateritic rises, often in open communities with no other eucalypt species.

A zone of intergradation occurs between the two subspecies in far north-western Queensland, to the north and north-west of Mt Isa. Specimens from this region show aspects of both subspecies, but are not uniformly intermediate. These specimens also tend to have generally larger fruits than those commonly found in either subspecies.

Conservation status: Widespread and locally abundant, this subspecies is not considered to be at risk.

Selected specimens (from 27 examined): Northern Territory: Daly Waters district, *White 250*, June 1922 (NSW); 154 miles [246 km] N of Tennant Creek, *Beadle 218*, 11 Sep 1972 (NSW); 50.3 km N of Renner Springs, *Hill 3260, Johnson & Stanberg*, 8 Nov 1988 (NSW); 10 miles [16 km] S of Renner Springs; *Dunlop 1847*, 19 Aug 1970 (DNA, NSW); tableland, 250 miles [400 km] N of Alice Springs, *Allen 676*, July 1922 (NSW).

Queensland: near Normanton, *Lazarides 4302*, 8 Mar 1954 (CANB, NSW); Normanton township, *Symon 4991*, 30 May 1967 (AD (ADW 44434), BRI, CANB, NSW).

Intergrading populations, subsp. *setosa* – subsp. *pedicellaris*

Selected specimens (from 4 examined): Queensland: 4 miles [6.4 km] W of 'Wernadinga' homestead on Normanton road, *Carolin 9023*, 2 May 1974 (NSW); 33 km SW of Normanton, *Benson 858*, 21 June 1974 (NSW).

66B. ACIXOSP **Corymbia setosa** *(Schauer) K.D. Hill & L.A.S. Johnson* subsp. **pedicellaris** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Ab subspecie *setosa* pedicellis saepissime plus quam 7 mm longis, foliis juvenilibus petiolatis, distinguitur.

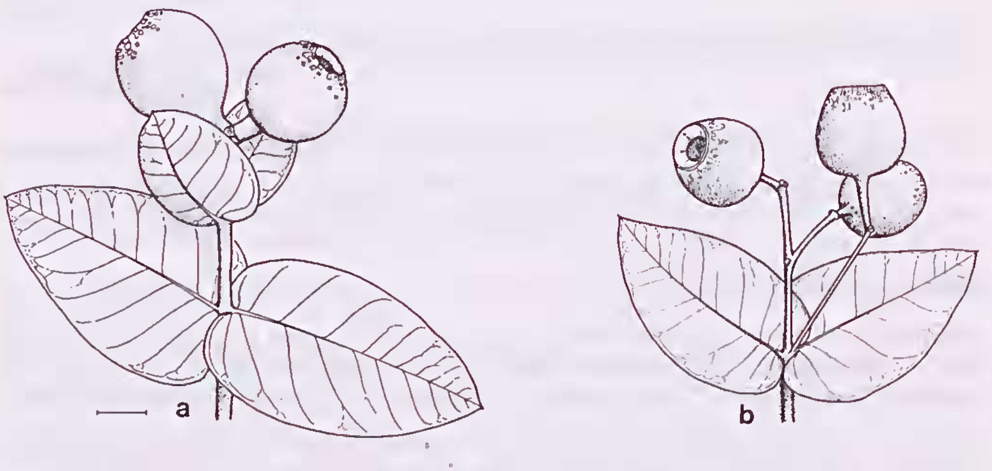

Fig. 76. C. *setosa* subsp. *setosa*. a, adult leaves and fruits (from *Beadle 218*). C. *setosa* subsp. *pedicellaris*. b, adult leaves and fruits (from *Hill 3700 & Stanberg*). Scale bar = 2 cm.

Type: Queensland: 38.0 km W of Charters Towers on highway, *K. Hill 3715 & L. Stanberg*, 28 July 1990 (holo NSW; iso BRI, CANB).

Petioles of juvenile leaves 1.5–5 mm long. Adult leaves 2–6 cm long, 10–50 mm wide; petioles 0–1 mm long. Peduncles 6–25 mm long; pedicels 3–15 mm long. Fruits 13–24 mm long, 13–22 mm diam. Fig. 76.

Flowering: Recorded Sep, Nov.

Distinguished by the mostly small to medium-sized fruits with elongate, slender pedicels, the relatively long bristle-glands with development of short simple trichomes towards the tips, and the often petiolate juvenile leaves. Adult leaves are generally shortly setose, ovate to orbicular and apically rounded. Their texture is relatively thin in the north, becoming thicker in the south-west of the range.

Subsp. *pedicellaris* is confined to the more eastern part of Queensland, in scattered stands from Musgrave Station in south-eastern Cape York Peninsula southward to east of Barcaldine (Fig. 74). It occurs on poor, sandy or sometimes stony sites, sometimes on deep red lateritic earths. Usually it forms single-stemmed small trees, but occasionally grows to much larger size on the deeper, red soils. Fruit size shows a general trend from small in the north to large in the south and west.

Hybrids with C. *brachycarpa* are known in areas where the two parent species occur (Appendix 1).

The epithet (from the neo-Latin *pedicellaris*) refers to the longer pedicels as compared twith those of subsp. *setosa*.

Conservation status: Widespread and locally abundant, this subspecies is not considered to be at risk.

Selected specimens (from 29 examined): Queensland: 24 km E of Musgrave towards Lakefield, *Hill 1914, Hind & Healy*, 1 Aug 1986 (NSW, BRI, CANB, PERTH); c. 28 miles [45 km] NW of Walsh River crossing, *Brooker 3377*, 27 Jan 1972 (CANB, NSW); near base camp, Croydon township, *Speck 4750*, 21 July 1954 (CANB, NSW); 100 miles [160 km] S of Mt Garnet, *Wiens & Barlow 4867*, 2 Nov 1972 (NSW); 12.9 km from Laroona road on Ewan road, *Hill 3593 & Stanberg*, 5 Dec 1988 (NSW); 'Chudleigh Park' station, southern Gregory Range, *Hill 3729 & Stanberg*, 29 July 1990 (NSW, BRI, CANB); 50.7 km N of Belyando River on Clermont to Charters Towers road, *Hill 3700 & Stanberg*, 22 July 1990 (NSW, BRI, CANB); 14.2 km along Red Mountain road from turnoff W of Lochnagar Siding, *Hill 3873 & Johnson*, 23 May 1991 (NSW, BRI, CANB); 34 km E of Barcaldine on Jericho road, *Hill 1750, Hind & Healy*, 19 July 1986 (NSW, BRI).

67. ACIXOY **Corymbia pachycarpa** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Folia adulta magna, crassa, acuta, saepe elongata. Ramuli adulti pruinosi. Alabastra magna, pyriformia, setoglandulis distinctis longis instructa. Fructus maximi, squamosi setosique, globulares vel urceolati, crassi, in pedicellis longis crassisque.

Type: Western Australia: 3.6 km S of highway on Billiluna road, *K. Hill 991, L. Johnson & D. Benson*, 2 Aug 1984 (holo NSW; iso CANB, DNA, PERTH).

Tree to 6 m, usually of poor form. *Rhizomes* not recorded. *Bark* persistent throughout, brown to grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* not seen. *Juvenile leaves* opposite, setose with bristle-glands and bearing simple hairs, ovate, to 9 cm long, to 30 mm wide, *petioles* to 1 mm long. *Intermediate leaves* opposite, setose with bristle-glands, ovate to oblong, to 13 cm long, to 50 mm wide, sessile. *Adult leaves* opposite, weakly discolorous, amphistomatic, bristle-free or setose, grey-green, ovate to oblong, 4–10 cm long, 20–46 mm wide, sessile; *intramarginal vein* distinct, within 1 mm of margin; *oil glands* sparse to frequent, superficial. Branchlets pruinose. *Umbellasters*

7-flowered; *peduncles* terete or slightly winged, 10–32 mm long, *pedicels* 7–20 mm long. *Mature buds* ovoid or pyriform, setose with long or short bristle-glands, not scurfy, 15–25 mm long, 8–10 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemispherical. *Fruits* ovoid-urceolate, distinctly constricted well below top, smooth or becoming brown-scaly, 24–30 mm diam., 18–28 mm long, 3- or 4-locular; *disc* 3–7 mm wide. *Seeds* 11–14 mm long including wing. Fig. 77.

Distinguished within the subseries by the combination: adult leaves large, thick, setose, acute, often elongate; umbellasters 7-flowered; buds large, pyriform, with distinct, long bristle-glands; fruits very large, scaly and setose, globular to urceolate, thick-walled, on short to long, thick pedicels.

In Western Australia restricted to the south-eastern Kimberley Region, south and east from Tableland station, extending south to the edge of the Tanami Desert and east into the Northern Territory to the Lajamanu district (Fig. 71).

The epithet is from the Greek, *pachys*, thick, and *karpos* (latinised as *carpus*), a fruit, referring to the large, thick-walled fruits.

Two geographic subspecies are recognised on differences in indumentum and size of adult leaves.

1 Adult leaves setose .... 67A. subsp. **pachycarpa**

1* Adult leaves not setose .... 67B. subsp. **glabrescens**

67A. ACIXOYA **Corymbia pachycarpa** *K.D. Hill & L.A.S. Johnson* subsp. **pachycarpa**

Adult leaves lanceolate to ovate, 5.5–10 cm long, 20–60 mm wide, setose with bristle-glands. Peduncles 12–32 mm long; pedicels 7–20 mm long. Fruits 26–35 mm long, 20–28 mm diam. Fig. 77.

Flowering: Recorded Dec.

This is the north-western subspecies, occurring in the south-eastern Kimberley region of Western Australia and extending eastward into the Northern Territory (Fig. 71).

Conservation status: Infrequently collected from widely scattered and remote localities, possibly rare, but probably not under threat. 3K.

Selected specimens (from 9 examined): Western Australia: 'Tablelands' station, *Done 355*, 1 Aug 1980 (DNA), *Done 355*, 21 Oct 1980 (DNA); 'Bedford Downs' station, 54 km W of Ord River crossing, *Brooker 7748*, 27 Oct 1982 (CANB, NSW).

Northern Territory: 20 km E of Nelson Springs turnoff on Buchanan Highway, *Hill 3531 & Stanberg*, 30 Nov 1988 (NSW); 'Inverway' station, 170 miles [270 km] E of Halls Creek, *Scott*, Dec 1967 (NSW).

67B. ACIXOYG **Corymbia pachycarpa** *K.D. Hill & L.A.S. Johnson* subsp. **glabrescens** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Folia adulta late lanceolata vel ovata, 4–7 cm longa, 20–40 mm lata, setoglandulis absentibus vel paucissimis. Pedunculi 10–16 mm longi; pedicelli 7–10 mm longi. Fructus 24–30 mm longi, 18–25 mm diametro.

Type: Northern Territory: 67 km SSW of Wave Hill towards Hooker Creek, *Gittins 2335*, 5 July 1971 (holo NSW).

Adult leaves broad-lanceolate to ovate, 4–7 cm long, 20–40 mm wide, bristle-free or almost so. Peduncles 10–16 mm long; pedicels 7–10 mm long. Fruits 24–30 mm long, 18–25 mm diam. Fig. 77.

Flowering: Not recorded.

Distinguished from subsp. *pachycarpa* by the relatively smaller and almost or wholly bristle-free adult leaves. Peduncles and pedicels are also generally shorter, and fruits generally smaller.

Subspecies *glabrescens*, which we have not seen in the field, is confined to the Northern Territory and occurs to the south-east of the type subspecies, apparently very sporadically in semidesert country (Fig. 71).

The epithet is from the Latin *glabrescens*, becoming smooth, referring to the bristle-free condition of the adult leaves.

Conservation status: Possibly rare, but unlikely to be at risk in view of the remote habitat. 3K.

Specimens examined: Northern Territory: Lajamanu rubbish dump, *Nash 215*, 29 May 1987 (DNA); 428 km W of Stuart Highway on track to Lajamanu, *Leach 1780*, 4 Mar 1988 (DNA); Tanami, *Jensen per Allen 204*, 1911 (NSW).

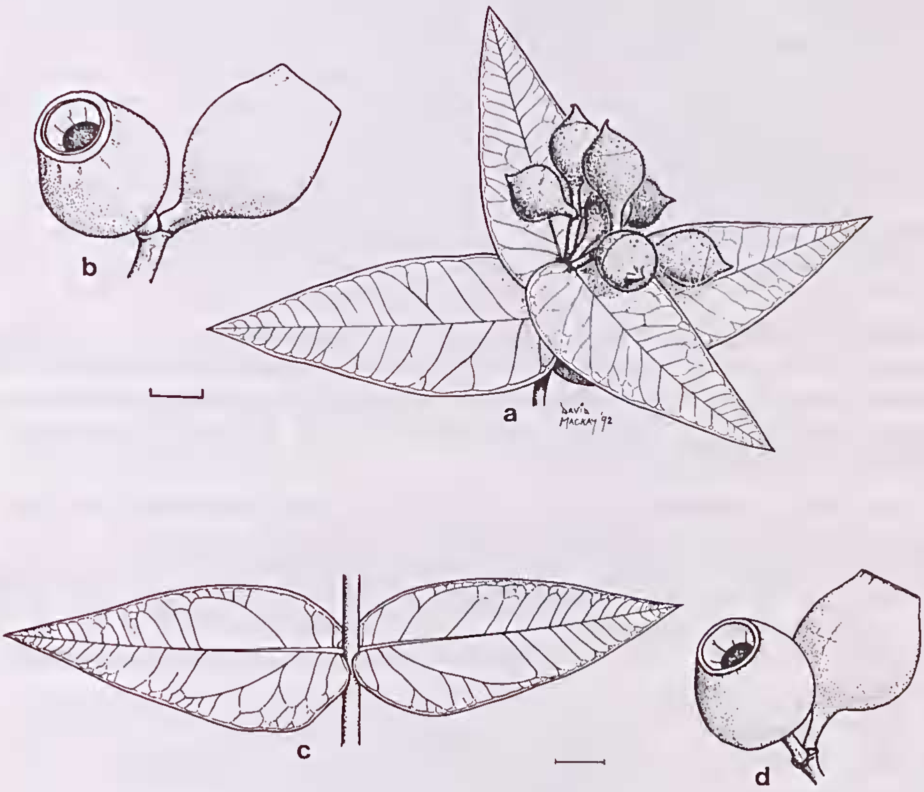

Fig. 77. C. *pachycarpa* subsp. *pachycarpa*. a, adult leaves, inflorescence and buds. b, fruits (from *Hill 3531 & Stanberg*). C. *pachycarpa* subsp. *glabrescens*. c, adult leaves. d, fruits (from *Gittins 2335*). Scale bar = 2 cm.

ACIXU Subseries **Deserticolosae**

Adult (and earlier) leaves not connate; bristle-glands bearing spreading colourless simple hairs; fruits small.

A subseries with two disjunct species.

68. ACIXUA **Corymbia papillosa** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Setoglandulae breves, trichomatibus multis distinctis transparentibus dense vestitae. Folia adulta tenuia, ad apicem saepe rotundatum vel apiculatum, anguste elliptica vel oblonga. Inflorescentiae foliosae umbellastris 7-floris. Alabastra parva. Fructus ellipsoidei, parvi, parietibus tenuibus, in pedicellis longis gracilibus bene definitis.

Type: Northern Territory: 5.7 km E of Ramingining turnoff on Gove road, *K.D. Hill 3917 & L. Stanberg*, 25 Aug 1991 (holo NSW; iso BRI, CANB, DNA, MEL).

Tree to 6 m, usually of poor form. *Rhizomes* not recorded. *Bark* persistent throughout, brown to grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* not seen. *Juvenile leaves* not seen. *Intermediate leaves* opposite, densely setose with short bristle-glands bearing very short simple trichomes, ovate to oblong, to 10 cm long, 50 mm wide, subsessile. *Adult leaves* opposite, weakly discolorous, amphistomatic, densely setose with short trichomatiferous bristle-glands, green, ovate to oblong, 4–10 cm long, 20–50 mm wide; *petioles* 2–6 mm long; *intramarginal vein* distinct, within 1 mm of margin; *oil glands* abundant, superficial. *Umbellasters* 7-flowered; *peduncles* terete or slightly winged, 5–30 mm long, *pedicels* (2-)4–9 mm long. *Mature buds* ovoid or pyriform, densely setose with short bristle-glands bearing very short simple hairs, 5–6 mm long, 4–5 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemispherical. *Fruits* ovoid to globose, distally narrowed, brown-scaly, 13–17 mm long, 8–13 mm diam., 3- or 4-locular; *disc* 2–4 mm wide. *Seeds* 8–11 mm long including wing. Fig. 78.

Distinguished within the series by the combination: bristle-glands short, with a thick coat of distinct transparent trichomes; adult leaves thin, often apically rounded or apiculate, elliptical to oblong; inflorescences leafy; umbellasters 7-flowered; buds small.

Scattered and apparently not abundant, across the northern parts of the Northern Territory, north of 14°S, with two isolated occurences known in the north-central Kimberley region of Western Australia (Fig. 79). A disjunction also apparently occurs in the distribution in the Northern Territory, with no recorded occurrences between about 130°30' and 132°30' E.

In *C. papillosa* the inflorescences are not clearly demarcated from leafy shoots, and lower umbellasters are usually subtended by expanded leaves rather than by fugacious bracts as is usual in *Corymbia*. The inflorescences are also frequently terminated by a flower rather than a suppressed vegetative bud as is more frequently seen in the genus (see comment on *C. dunlopiana*). A similar condition occurs in the occasionally sympatric *C. dunlopiana*, and may be regarded as a secondary (apomorphic) reversion.

The epithet is from the Latin *papilla*, a nipple, and *-osus*, full of, referring to the abundant short, more or less papilliform trichomes on the bristle-glands.

Two geographically separated subspecies are recognised.

1 Fruits ellipsoidal, less than 13 mm diam., pedicels more than 4 mm long .... 68A. subsp. **papillosa**

1* Fruits spherical, more than 13 mm diam., pedicels less than 4 mm long .... 68B. subsp. **globifera**

68A. ACIXUAP **Corymbia papillosa** *K.D. Hill & L.A.S. Johnson*, subsp. **papillosa**

Adult leaves narrowly elliptical to oblong, 4–10 cm long, 20–50 mm wide; petioles 2–6 mm long. Peduncles 5–30 mm long; pedicels 4–9 mm long. Fruits ellipsoidal, 14–17 mm long, 11–13 mm diam. Fig. 78.

Flowering: Not recorded.

Distinguished by the small, ellipsoid, relatively thin-walled fruits on long, slender, clearly-defined pedicels.

Scattered, and apparently not abundant, across the northern parts of the Northern Territory, north of 14°S (Fig. 79). This subspecies occurs as a small, twisted tree on shallow or skeletal sandy or lateritic soils mainly on ridges or slopes. Records from the east of the range, however, indicate that it also grows on seasonally swampy sandy flats and as an understorey tree in *Eucalyptus (Fibridia) tetrodonta* forests. It is sympatric with *C. dunlopiana* in some localities in the west of the range, for example in the South Alligator River Valley, and apparently closely parapatric with *C. chartacea* within the range of the latter.

Conservation status: Locally abundant over a considerable area in country fairly remote from settlement, not considered to be at risk.

Selected specimens (from 18 examined): Northern Territory: Port Keats, MMR 32.16, *Robinson*, 28 Sep 1972 (DNA 5138); 1 mile [1.6 km] from west shoreline opposite Peron Island, *Byrnes 1681*, 17 Feb 1970 (NSW); 53.7 km from Labelle Downs homestead on track to Channel Point, *Hill 4041 & Stanberg*, 8 Sep 1991 (NSW, CANB, DNA); Sleisbeck road, c. 18 km SE of El Sharana, *Dunlop 4966*, 9 July 1978 (NSW, BRI, CANB, DNA, K); Nabarlek, *Hinz 57*, 6 Nov 1988 (DNA, NSW); 3.1 km E of Dhalinbuy turnoff, *Hill 3950 & Stanberg*, 27 Aug 1991 (NSW, CANB, DNA); 19.4 km from Maningrida to Ramingining road on Bulman road, *Hill 3999 & Stanberg*, 1 Sep 1991 (NSW, CANB, DNA); 70.7 km E of Badalngarrmirri Creek, *Hill 3938 & Stanberg*, 26 Aug 1991 (NSW, CANB, DNA); Arnhem Land, 'Arafura' homestead turnoff (12°28'S 134°54'E), *Clark 1291*, 23 July 1987 (DNA, CANB, NSW); near BHP airstrip (12°54'S 135°28'E), *Maconochie 1492*, 17 June 1972 (DNA, NSW); 130 km SE of Nhulunbuy, *Wightman 2236*, 12 Sep 1985 (DNA, CANB); S Caledon Bay (12°55'S 136°25'E), *Latz 2919*, 22 June 1972 (DNA, CANB, MEL, NSW).

68B. ACIXUAX **Corymbia papillosa** *K.D. Hill & L.A.S. Johnson*, subsp. **globifera** *K.D. Hill & L.A.S. Johnson* **subsp. nov.**

Ab subspecie *papillosa* pedicellis brevioribus et fructibus majoribus globosisque differt.

Type: Western Australia: 94.2 km W of Hann River crossing on Mt Elizabeth to Pantijan track, *K.D. Hill 4102 & L. Stanberg*, 18 Sep 1991 (holo NSW; iso CANB, DNA, PERTH).

Adult leaves ovate to elliptical, 4–7 cm long, 23–38 mm wide; petioles 2–4 mm long. Peduncles 10–17 mm long; pedicels 1–2 mm long. Fruits spherical, 13–17 mm long, 13–16 mm diam. Fig. 78.

Flowering: Not recorded.

Distinguished from subsp. *papillosa* by the larger, spherical fruits on short, thick pedicels.

Known at present only from the north-central Kimberley region, N and NW of Mt Elizabeth Station (Fig. 79), on sandy soils. No other taxa of series *Ferrugineae* occur in the same region (*C. ferruginea* subsp. *stypophylla* occurs to the east and south-east).

The epithet is from the Latin *globifera*, globe(sphere)-bearing, from the spheroidal fruits.

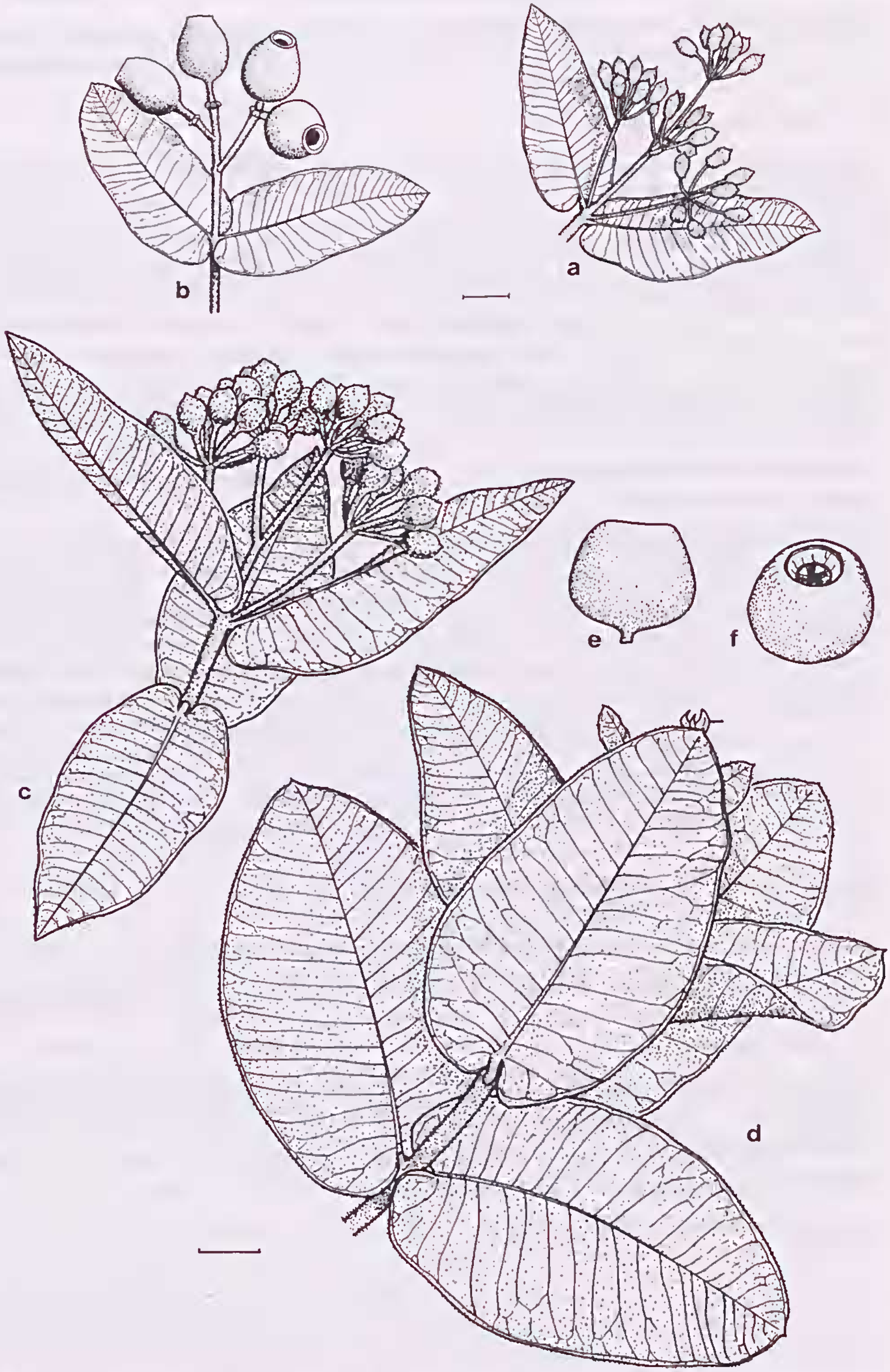

Fig. 78. *C. papillosa* subsp. *papillosa*. a, adult leaves and buds. b, adult leaves and fruits.*C. papillosa* subsp. *globifera*. c, adult leaves, inflorescence and buds. d, fruits (a from *Hinz 57*, b from *Clarke 1291*, c from *Hill 4101 & Stanberg*, d from *Hill 4102 & Stanberg*). Scale bar = 1 cm.

Conservation status: possibly rare, but occurring in very remote regions. 3K.

Specimens examined : Western Australia: 70 miles [112 km] NNW of Gibb River Station, *Speck 4966*, 7 Sep 1954 (CANB); 33.6 km N of Drysdale River crossing on Kalumburu road, *Hill 4076 & Stanberg*, 14 Sep 1991 (NSW, BRI, CANB, DNA, PERTH); on Mt Elizabeth to Panter Downs road, *Done 471*, 23 June 1981 (DNA).

69. ACIXUD **Corymbia deserticola** *(D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus deserticola* D.J. Carr & S.G.M. Carr, Fl. Australia 19: 495 (1988); earlier publication by these authors, in Eucalyptus 2: 311 (1987), was invalid.

≡ *E. desertorum* D.J. Carr & S.G.M. Carr, Eucalyptus 1: 102 (1985), *nom. illegit.*; non Naudin, Descr. Emploi *Eucalyptus*: 64 (1891).

Type: Western Australia: Great Sandy Desert, 20°54'S 123°13'E, *A.S. George 15707*, 11 May 1979 (holo PERTH).

Few-stemmed mallee or tree, to 6 m. *Rhizomes* not recorded. *Bark* persistent throughout, brown to grey-brown, thick, flaky, deeply tessellated and vertically fissured, red-brown on freshly broken surfaces. *Cotyledons* orbicular, 3-veined, 8–10 mm long, 10–15 mm diam., petioles 2–4 mm long. *Juvenile leaves* opposite, sparsely setose, ovate, obtuse, sometimes apiculate, shortly petiolate for 3–4 nodes, then ± sessile, 13–34 mm long, 10–27 mm wide; *petioles* 1–3 mm long. *Intermediate leaves* disjunct, ± setose, lanceolate, somewhat larger than adult leaves, to 6 cm long, to 30 mm wide; *petioles* to 2 mm long. *Adult leaves* opposite, usually sparsely setose with bristle-glands ± covered with very short simple hairs when young, weakly discolorous, amphistomatic, ovate, cordate or sagittate, acute or apiculate, 2–6 cm long, 12–40 mm wide, *petioles* 1–4 mm long; *intramarginal vein* indistinct, formed from confluent extensions of secondary lateral veins, not always continuous; *oil glands* frequent, superficial. *Umbellasters* 7-flowered; *peduncles* terete, 5–17 mm long; *pedicels* terete, 2–6 mm long. *Mature buds* ovoid, usually ± setose with short to medium-length bristle-glands often bearing some very short simple trichomes, 5–6 mm long, 3–4 mm diam., operculum about as long as hypanthium, conical, acute or apiculate. *Fruits* 4–5-locular, urceolate, distally flared or narrowed, smooth or becoming brown-scaly, 10–16 mm long, 9–14 mm in diameter; *disc* c. 2 mm wide; dehiscence often circumscissile. *Seeds* 6–9 mm long including wing. Fig. 80.

C. deserticola is distinguished within series *Ferrugineae* group by the small, subsessile or shortly pedicellate fruits, and the small, thick, more or less setose adult leaves. The twigs are usually strongly setose, with very short simple trichomes on the bristle-glands.

In Western Australia through the Pilbara Region, south to Mt Augustus and east to the south-western Great Sandy Desert, reappearing in the Northern Territory on the northern and eastern side of the Tanami Desert, widely scattered but not in dense stands (Fig. 79). This species occupies a range of habitats, from dry rocky slopes to red sandhills, usually not on the highest or lowest points, though it is present on the summit ridge of Mt Augustus and on some high points in the Hamersley Range. It occurs in *Acacia* shrublands, sometimes in association with *Eucalyptus (Odontocalyptus) gamophylla*, *E. (Symphyomyrtus) leucophloia* subsp. *leucophloia* and *C. candida*. Although in dry country it is not confined to recognised 'deserts'.

The Northern Territory populations differ in details of adult leaves and fruits, and are recognised here as a separate subspecies.

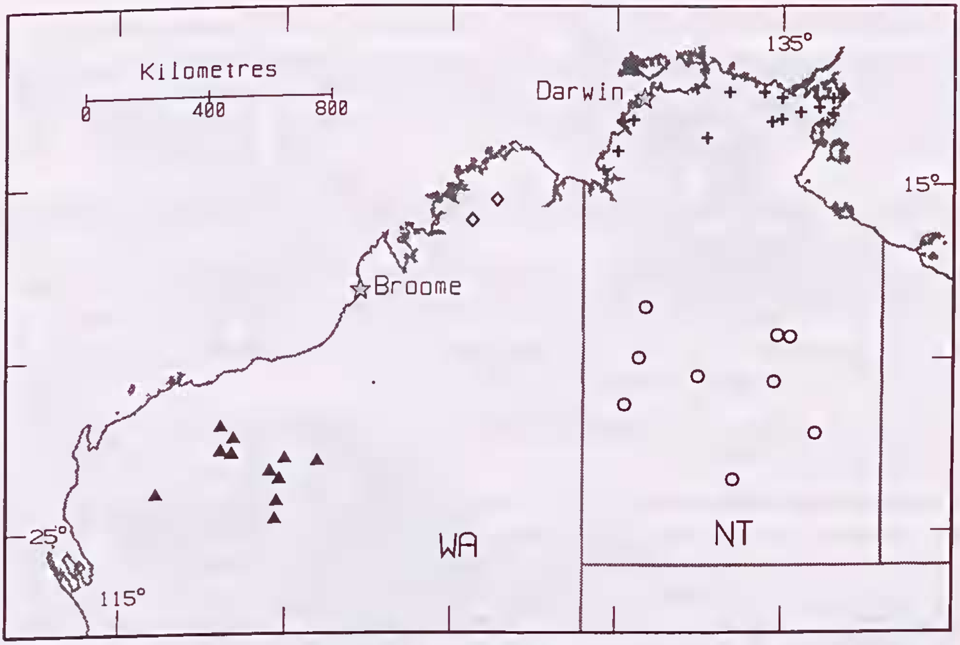

Fig. 79. Distribution of *C. papillosa* subsp. *papillosa* (plus), *C. papillosa* subsp. *globifera* (diamond), *C. deserticola* subsp. *deserticola* (triangle), subsp. *mesogeotica* (circle).

1 Adult leaves acute, fruits brown-scaly .... 69A. subsp. **deserticola**

1* Adult leaves rounded, fruits not scaly .... 69B. subsp. **mesogeotica**

69A. ACIXUDE **Corymbia deserticola** *(D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson* **subsp. deserticola**

Adult leaves bristle-free or shortly setose, acute, 2–6 cm long, 12–27 mm wide; petioles 2–4 mm long. Fruits finely brown-scaly, frequently flared at top, 10–13 mm long, 9–12 mm diam.; pedicels 2–4 mm long. Fig. 80.

Flowering: Not recorded.

Distinguished by the acute adult leaves and the generally smaller, finely brown-scaly fruits with shorter pedicels.

Subsp. *deserticola* is widely scattered in sites characteristic of the species through the western part of the species' range (Fig. 79).

Conservation status: Widespread and locally abundant, this subspecies is not considered to be at risk.

Selected specimens (from 13 examined): Western Australia: 60.2 km W of Wittenoom on track to Millstream, *Hill 436, Johnson, Blaxell, Brooker & Edgecombe*, 30 Oct 1983 (NSW, CANB, PERTH); Joffre Falls road c. 3 km W of Dales Gorge turnoff, *Willis*, 15 Aug 1974 (MEL 501843, NSW); 70 km N of Newman on Great Northern Highway, *Hill 495, Johnson, Blaxell, Brooker & Edgecombe*, 2 Nov 1983 (NSW, AD, CANB, MEL, PERTH); 30 km E of Newman to Nullagine road on Jiggalong road, *Pryor*, 20 Aug 1985 (NSW); 60 miles [96 km] W of Lake Disappointment, *Royce 'C'*, 6 June 1973 (PERTH, CANB); Mt Augustus, at head of ravine N of Beedoboondum, *Johnson 9348 & B. Briggs*, 3 Aug 1991 (NSW); 13.2 km N of Kumarina roadhouse on Great Northern Highway, *Hill 499, Johnson, Blaxell & Brooker*, 2 Nov 1983 (NSW).

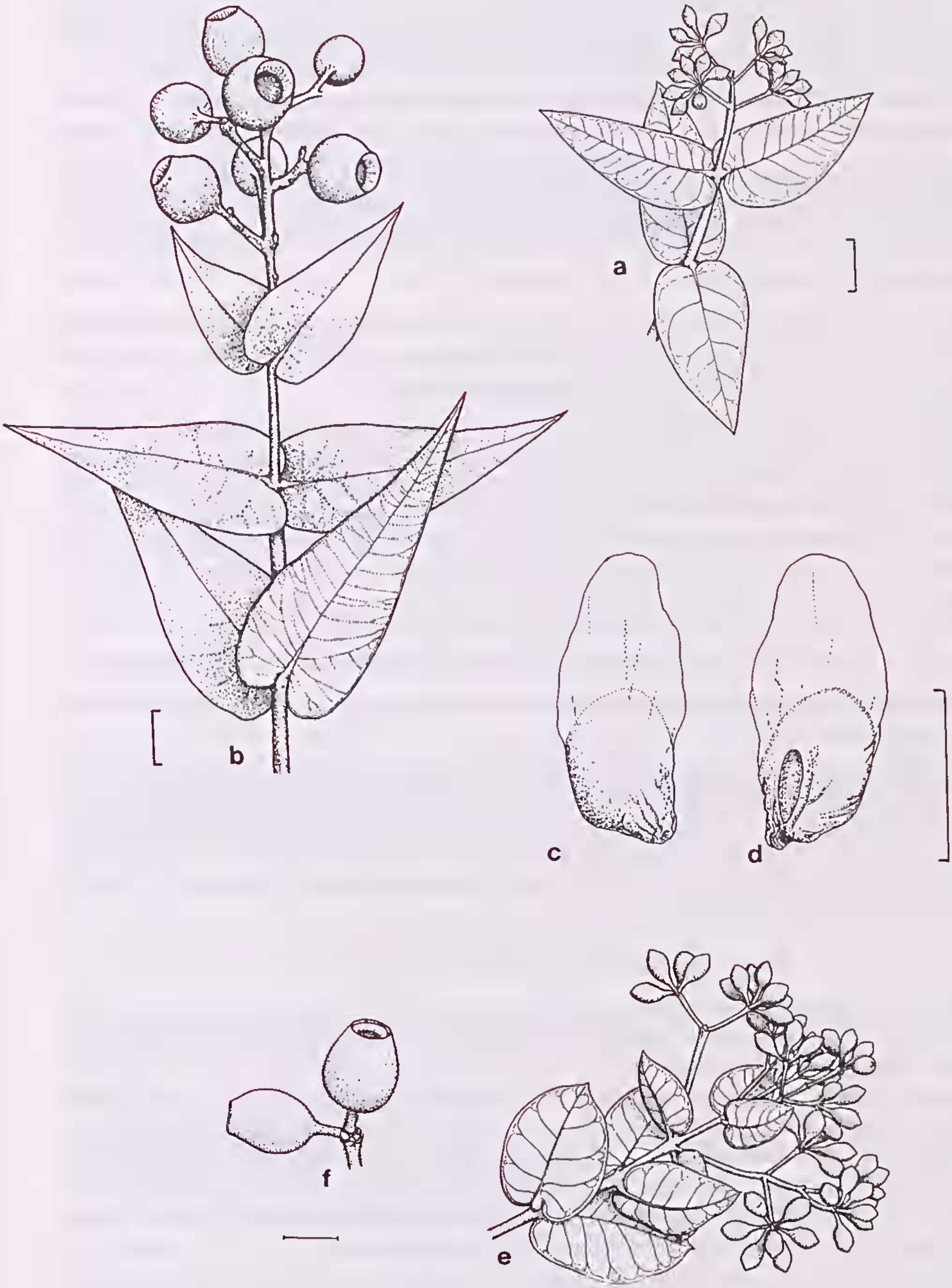

Fig. 80. *C. deserticola* subsp. *deserticola*. a, adult leaves, inflorescence and buds. b, adult leaves and fruits. c, d, seed (from *Willis MEL 501843*). *C. deserticola* subsp. *mesogeotica*. e, adult leaves, inflorescence and buds. f, fruits (e from *Forster 6134*, f from *Dunlop 1789*). Scale bar: a, b, e, f = 1 cm; c, d = 5 mm.

69B. ACIXUAM **Corymbia deserticola** *(D.J. Carr & S.G.M. Carr) K.D. Hill & L.A.S. Johnson* subsp. **mesogeotica** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Folia adulta mediocria, breviter setosa, rotundata, saepissime subtiliter apiculata. Fructus sparse setosi sed plerumque non squamosae, ovoidei, saepissime non urceolati (ad summum non expansi); pedicelli quam eis subspecies typicae longiores.

Type: Northern Territory: c. 300 km E of Stuart Highway on Mt Isa road (20°04'S 136°46'E), *K.D. Hill 3886 & L. Stanberg*, 21 Aug 1991 (holo NSW; iso CANB, DNA).

Adult leaves shortly setose, rounded, usually finely apiculate, 3–6 cm long, 25–40 mm wide; petioles 1–3 mm long. Fruits lightly setose but usually not scaly, ovoid, usually not flared at top, 12–16 mm long, 11–14 mm diam.; pedicels 4–6 mm long. Fig. 80.

Flowering: Not recorded.

Adult leaves tend to be larger, rounded, and more consistently setose than in subsp. *deserticola*, and the indumentum is generally lighter in colour. Fruits are mostly not scaly, and also tend to be larger with longer pedicels.

Subspecies *mesogeotica* ranges from the central Tanami Desert north to Lajamanu and east to around Wonarah and Ooratippra (Fig. 79). It occurs mainly on red aeolian sands, less frequently on stony or lateritic sites, always with *Triodia*. It is broadly sympatric with *C. sphaerica* in the west of the range and with *C. setosa* subsp. *setosa* in the east. It lacks the white branchlets of *C. setosa* (discussed under that species).

Hybrids are known with *C. eremaea* subsp. *oligocarpa* (Appendix 1).

The epithet is from the Greek *mesogeotikos*, inland, referring to the distribution.

Conservation status: Widespread and locally abundant, this subspecies is not considered to be at risk.

Selected specimens (from 8 examined): Northern Territory: 415 km W of Stuart Highway on Lajamanu track, *Leach 1799*, 4 Mar 1988 (DNA, NSW); Whistleduck Gorge, Davenport Range, *Latz 9752*, 22 Sep 1983 (DNA, NSW); 67 km from Three Ways on Camooweal road, *Forster 6134*, 6 Dec 1989 (BRI, DNA, NSW); 58 miles [93 km] SSW The Granites, *Dunlop 1789*, 31 July 1970 (NSW, DNA); 16.7 miles [26.7 km] E of Wonarah telegraph station, *Chippendale NT 3840 & Johnson*, 2 Oct 1957 (DNA, NSW).

ACO Section **Ochraria**

Rhizomes not recorded. Bark persistent except on small branches. Simple hairs not present on most juvenile stages (simple hairs do occur on the hypocotyl in *C. watsoniana* at least). Adult leaves hypostomatic or, more commonly, amphistomatic. Oil glands abundant, usually obscured by epidermis, often more than one per vein islet. Mesophyll fibres absent. Inflorescence ± terminal to infraterminal. Umbellasters 7-flowered, rarely reduced to 3-flowered. Calyx calyptriform, membranous, shedding early. Corolla calyptriform, thickened. Style straight in bud, tip engaged in the calyptra. Stigma tapered, with short papillae. Columella present in open fruits. Seeds wingless, smooth, with reticulate cracking in testa.

This section encompasses the yellow bloodwoods, a group recently revised by Brooker and Bean (1991). The section has been critically reviewed by us, and our treatment is very largely in agreement with that of Brooker and Bean, which may be consulted for more detail and illustrations. The species included constitute a closely coherent group, and consequently series and subseries are not distinguished. Twelve species are recognised, 11 from subtropical and cooler tropical areas in eastern Queensland, with a single disjunct species in eastern New South Wales (Fig. 17).

Both Bentham (1867) and Maiden (1923) placed the yellow bloodwoods with the *Corymbosae*. Blakely (1934) placed them in subseries *Ochrophloiae* with *E. torelliana*, and Blake (1953) placed them in the *Corymbosae* with all other bloodwoods. Pryor and Johnson (1971) treated them as a series within section *Ochraria*, which also included *E. torelliana* and the spotted gums as another two distinct series. Chippendale accepted the three series in this group as proposed by Pryor and Johnson, taking up Maiden's seed-series name *Naviculares* (which was not intended by Maiden as a formal taxonomic name) for the yellow bloodwoods. Carr and Carr (1987) placed the yellow bloodwoods in a separate series, which, together with a series encompassing *E. torelliana* and the spotted gums, constituted a section equivalent to section *Ochraria* of Pryor and Johnson. Brooker and Bean (1991) treated the yellow bloodwoods as a series, placing them with the other five series of 'woody-fruited bloodwoods' as recognised by Chippendale, but not commenting further on relationships.

The sectional epithet is from Latin *ochra*, (yellow) ochre (ultimately from Greek), referring to the characteristic colour of the bark.

The group is united by the (apomorphic) thickened petaline calyptra with the style engaged in a pit therein, and the soft, persistent, rather thickly scaly, yellow bark. The shortly papillate stigma and the loss of mesophyll fibres are apomorphic conditions shared with *Politaria*, *Cadagaria* and *Blakearia*, probably together with the calyptrate, early-shedding calyx. Simple trichomes are largely absent, but not always entirely so. The smooth, cracking, dorsiventrally flattened seeds are plesiomorphic. The peltate juvenile leaves on long petioles are also regarded as plesiomorphic, this condition apparently being labile in this section. As in other sections with peltate juvenile leaves, very earliest stages (before node 5) are non-peltate and opposite, succeeding stages quickly becoming disjunct, but not always peltate in this group.

Within the group, phylogenetic trends are less clear. The peltate juvenile and bristle-free, hypostomatic adult conditions in *C. leptoloma* are probably homologous with the plesiomorphic conditions seen in sections *Cadagaria* and *Politaria* (though these two are amphistomatic), as well as in section *Apteria* and the plesiomorphic series *Gummiferae* in section *Rufaria* (section *Fundoria* has non-peltate juvenile leaves). Amphistomatic leaves are then apomorphic for the remainder of section *Ochraria*. Two divergent trends (perhaps clades) may then be seen, one by reduction of the peltate stage, and the other by neotenous retention of the peltate stage. Increase in fruit size may represent a third trend, although this is not consistent with juvenile-leaf characters, and homoplasy is clearly involved in one or the other.

70. ACOYYA **Corymbia leptoloma** *(Brooker & A.R. Bean) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus leptoloma* Brooker & A.R. Bean, Austrobaileya 3(3): 432 (1991).

Type: Queensland: North Kennedy: c. 12 km W of Paluma, *M.I.H. Brooker 10207*, 19 May 1989 (holo BRI; iso CANB, DNA, MEL, NSW).

Tree to 15 m. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* not seen. *Intermediate leaves* disjunct, bristle-free, narrow-ovate to suborbicular, acute to obtuse, peltate, to 15 cm long, to 75 mm wide; *petioles* to 12 mm long. *Adult leaves* disjunct, hypostomatic and strongly discolorous, very glossy above, lanceolate to broad-lanceolate, acuminate, 10–18 cm long, 25–50 mm wide; *petioles* 14–35 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, obscured. *Umbellasters* 7-flowered; *peduncles* 7–14 mm long; *pedicels* 0–2 mm long. *Mature buds* scurfy-white with remnants of rubbery cuticle, ovoid; c. 8 mm long, c. 6 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 9–11 mm long, 9–11 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Not recorded.

Distinguished within the group by the dense, heavy crown of large leaves, which are discolorous, hypostomatic and relatively thin. This is the only yellow bloodwood with hypostomatic adult leaves, consistent with its relatively mesic habitat.

C. leptoloma is known only from tall sclerophyll woodland on coarsely gritty sandy soil on granite in wetter parts on the western fall of the Paluma Range (Fig. 81). *C. leichhardtii* occurs in drier parts of the acid granite country a few kilometres to the west, with no apparent interbreeding.

Conservation status: 2R-.

Selected specimens (from 6 examined): Queensland: 14.0 km W of Paluma on Ewan road, *Brooker 10407*, 6 Mar 1990 (CANB, BRI, NSW, QRS); 14.9 km W of Paluma on road to Hidden Valley, *Blaxell 89/169*, *Johnson & D'Aubert*, 4 Aug 1989 (NSW).

71. ACOYYC **Corymbia leichhardtii** *(Bailey) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus leichhardtii* Bailey, Queensland Agric. J. 16: 493 (1906).

Type citation: 'Hab.: Near Alice, Central Railway (Received from Mr. Wm. Pagan,...'

Type: Queensland: near Alice, Central Railway, *W. Pagan* (holo BRI; iso G, NSW).

≡ *E. eximia* Schau. var. *leichhardtii* (Bailey) Ewart, Victorian Naturalist 24: 56 (1907).

≡ *E. peltata* Benth. subsp. *leichhardtii* (Bailey) L.A.S. Johnson & Blaxell, Contrib. New South Wales Nat. Herb. 4(7): 453 (1973).

Before Bailey's circumscription, this taxon was included in *E. eximia* Schauer (Mueller 1884). Maiden (Critical Revision Eucalyptus 5: 35, 1920) then synonymised *E. eximia* var. *leichhardtii* with *E. peltata* Benth. This treatment was subsequently followed until Johnson and Blaxell recognised *E. peltata* subsp. *leichhardtii* in 1973.

Tree to 15 m. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* disjunct after node 2–3, setose, elliptical to ovate, peltate after node 5, to 5 cm long, to 30 mm wide; *petioles* to 14 mm long. *Intermediate leaves* disjunct, bristle-free, narrow-ovate to suborbicularte, acute to obtuse, peltate, to 13 cm long, 55 mm wide; *petioles* to 13 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, dull to glossy, grey-green to green, narrow-lanceolate to lanceolate, acuminate, 8–18 cm long, 14–27 mm wide; *petioles* 10–27 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, mostly obscured, sometimes not. *Umbellasters* 7-flowered; *peduncles* 9–20 mm long; *pedicels* 0–4 mm long. *Mature buds* scurfy-white with remnants of rubbery cuticle, ovoid; 8–10 mm long, 5–6 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 9–15 mm long, 9–13 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Jan–Apr, also erratic, recorded July.

Distinguished within the group by the ovate, peltate juvenile leaves, the disjunct, dull greyish-green, lanceolate adult leaves, and the medium-sized fruits with short pedicels. Populations from the northern parts of the range differ from those in the south in that the calyptra does not bulge over the hypanthium (as it does also in

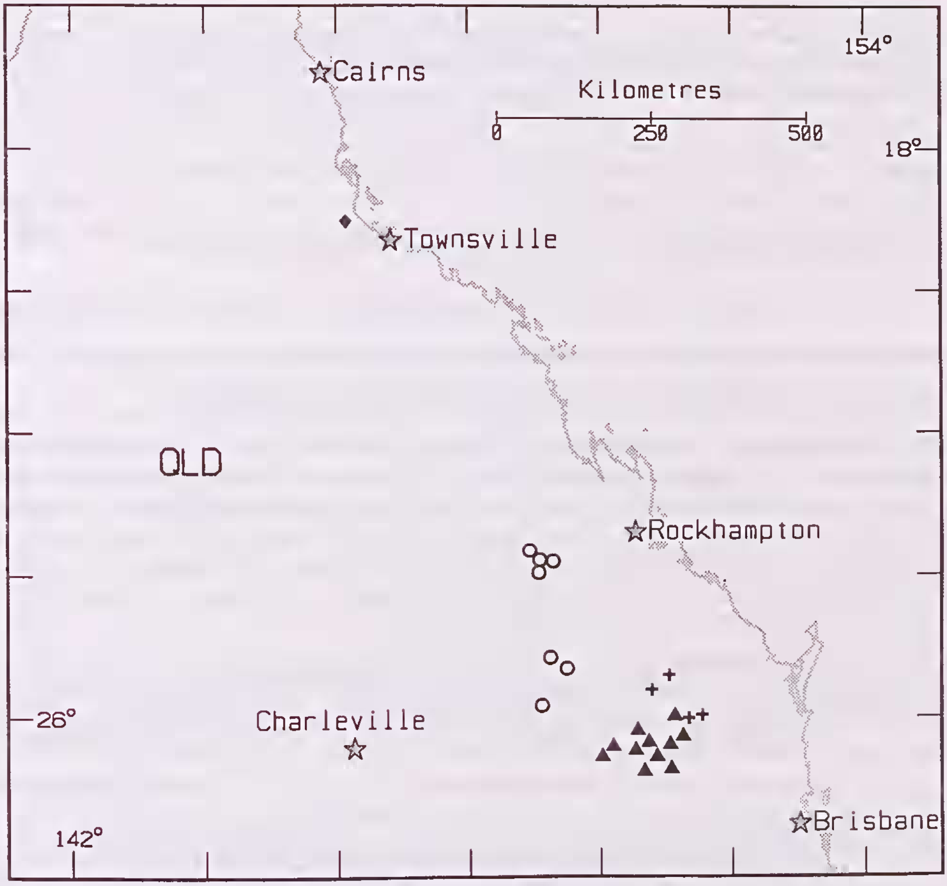

Fig. 81. Distribution of *C. leptoloma* (diamond), *C. bunites* (circle), *C. petalophylla* (plus), *C. bloxsomei* (triangle).

C. catenaria and *C. watsoniana*). Fruits are also generally slightly smaller in the north, as are the areoles in the ultimate leaf venation. Intergrading populations are recorded with *C. dimorpha* (see Appendix 1), which in turn intergrades with *C. peltata*.

C. leichhardtii is widespread but sporadic in distribution, in grassy or dry sclerophyll woodlands on sandy substrates, often over siliceous rocks. It ranges from Mt Mulligan (north-west of Mareeba), to west of Springsure (Fig. 82). This species forms a broad replacement pattern with other yellow bloodwood species, occurring on the coastal side of *C. peltata* in the north of the range, running inland further south to the west of *C. aureola* and *C. bunites*. Relationships with *C. catenaria* and, in turn, with *C. watsoniana* are discussed under *C. catenaria*.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 43 examined): Queensland: Mt Mulligan, *Clarkson 5285*, 12 Apr 1984 (BRI, CANB, K, MEL, NSW, QRS); Walsh Bluff, on the headwaters of Granite Creek, c. 4 km SSW of Walkamin, *Clarkson 2861*, 15 Feb 1980 (BRI, CANB, NSW); Stannary Hills, c. 18 km S of Mutchilba, *Clarkson 2516 & Byrnes*, 9 Aug 1979 (BRI, NSW); Lappa Range, W of Petford, *Johnson*, 20 May 1962 (NSW 302213); near Bakerville, *Hyland 5928*, 17 Mar 1972 (QRS, NSW); Jumna mine, Herberton to Irvinebank road, *Blaxell 1632*, 4 June 1978 (NSW); 38.6 km N of junction of Gulf Development Road along Kennedy Highway, *Blaxell 89/120, Johnson & D'Aubert*, 29 July

1989 (NSW, BRI, CANB); 1.6 km from Oak Park on road to Lyndhurst, *Hind 2485*, 12 Aug 1979 (NSW); 18.1 km W of Paluma on road to Hidden Valley, *Blaxell 89/172, Johnson & D'Aubert*, 4 Aug 1989 (NSW); 29.9 km from Pentland towards Charters Towers, *Hall 74/67*, 10 July 1974 (CANB, NSW); 7 miles [11 km] NW of 'Cerito' station, *Adams 972*, 21 May 1964 (CANB, NSW); 47.4 km from Clermont towards Alpha, *Brooker 10214*, 21 May 1989 (CANB, BRI, DNA, NSW); 18.5 km from Jericho-Barcaldine road on Red Mountain road, turnoff W of Lochnagar siding, *Hill 3874 & Johnson*, 23 May 1991 (NSW, BRI, CANB); 31.0 km W of Alpha on Jericho road, *Blaxell 89/031, Johnson & D'Aubert*, 24 July 1989 (NSW); 26.5 km W of Springsure on Tambo road, *Brooker 9782*, 14 Oct 1987 (CANB, NSW); Nogoa River camping area, Salvator Rosa National Park, *Blaxell 89/020, Johnson & D'Aubert*, 23 July 1989 (NSW, BRI, CANB).

72. ACOYYE **Corymbia bloxsomei** *(Maiden) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus bloxsomei* Maiden, Crit. Rev. Eucalyptus 7: 315, plate 275, 1926.

Type citation: 'The type is Hippong, Herbert Schreiber Bloxsome,...'

Type: Queensland: Hippong, *H.S. Bloxsome*, Oct 1919 (lecto NSW 10104, here designated). Several specimens collected by H.S. Bloxsome from Hippong were treated as syntypes by Maiden, and the caption for the illustration cites a Bancroft collection from the same locality as the type, together with Bloxsome collections. The above collection is selected as lectotype, being the earliest Bloxsome collection that is fully representative of the species, and also in consideration of the fact that Bancroft is not mentioned in the body of the protologue.

Tree to 15 m (or sometimes more). *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* soon disjunct, setose with bristle-glands, suborbicular to ovate, subpeltate after the first few nodes. *Intermediate leaves* disjunct, bristle-free, dull grey-green, broad-lanceolate to ovate, acute to obtuse, peltate early, later ones non-peltate, to 15 cm long, 70 mm wide; *petioles* to 10 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, very glossy, bright green, narrow-lanceolate to lanceolate, acuminate, 10–15 cm long, 10–33 mm wide; *petioles* 14–30 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, usually obscured by epidermis. *Umbellasters* 3–7-flowered; *peduncles* 8–22 mm long; *pedicels* 2–6 mm long. *Mature buds* green (non-scurfy), ovoid; 8–9 mm long, 5–6 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 13–18 mm long, 10–12 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Recorded Dec.

Distinguished by the relatively narrow, glossy green, bristle-free adult leaves, the subpeltate juvenile leaves, and the relatively small, distinctly pedicellate fruits. Juvenile leaves are ± peltate only between about nodes four and ten, and the peltate proximal portion of the lamina is very weakly developed.

Occasional intersectional hybrids with *C. variegata* (section *Politaria*) are known from places where the parent species occur together (see Appendix 1).

Locally abundant, in tall woodland or forest on frequently deep sandy soils in flat to slightly undulating country from south of Mundubbera to around Chinchilla (Fig. 81).

Conservation status: Given conservative forestry practices in its main areas, not likely to be at risk.

Selected specimens (from 30 examined): Queensland: 27.9 km from Mundubbera towards Chinchilla, *Brooker 3760*, 29 Aug 1972 (CANB, NSW); 20 miles [32 km] S of Wandoan, *Speck 1973*, 27 Apr 1964 (CANB, NSW); 5.2 km from Leichhardt Highway on Welshs Road (26°25'S

150°07'E), *Brooker 9791*, 16 Oct 1987 (CANB, NSW); c. 50 km NE of Chinchilla, near 'Durah' homestead, *Johnson 7089 & B. Briggs*, 23 May 1971 (NSW); 2–3 km N of Forestry Gate on Burncluith Road, Barakula State Forest, *Wallace 83051*, 21 Aug 1984 (NSW); 0.1 mile [0.2 km] W of Burra Burri, *Chippendale 578, 579 & Johnston*, 10 June 1968 (CANB, NSW); Ballon State Forest, near forest station, *Blake 19169, 19170*, 26 Mar 1953 (BRI, NSW).

73. ACOYYG **Corymbia bunites** *(Brooker & A.R. Bean) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus bunites* Brooker & A.R. Bean, Austrobaileya 3(3): 423 (1991).

Type: Queensland: Leichhardt: Blackdown Tableland, *M.I.H. Brooker 3779*, 31 Aug 1972, (holo BRI; iso CANB, K, MEL, NSW).

Tree to 25 m, but often much smaller. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* disjunct after node 2–3, setose with bristle-glands, elliptical to ovate, not peltate, to 8 cm long, to 50 mm wide; *petioles* to 7 mm long. *Intermediate leaves* disjunct, bristle-free, lanceolate, acute to acuminate, not peltate, to 12 cm long, 35 mm wide; *petioles* to 6 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, glossy to rather dull, narrow-lanceolate to lanceolate, acuminate, 8–18 cm long, 12–28(–40) mm wide; *petioles* 13–25 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, ± obscured. *Umbellasters* 7-flowered; *peduncles* 6–15 mm long; *pedicels* 1–3 mm long. *Mature buds* green (non-scurfy), ovoid; 6–7 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 8–11 mm long, 8–10 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: July–Sep.

C. bunites is distinguished from *C. leichhardtii* by the uniformly non-peltate juvenile leaves, which become bristle-free and lanceolate to broad-lanceolate at a very early stage. Adult leaves show slightly more open venation, and buds and fruits are generally smaller; the buds are green rather than silver-white. Adult leaves are generally duller in populations from the south of the range, most noticeably so in those from farther inland around Robinson Gorge, but they are amphistomatic in all cases.

Abundant around the steeper parts of the Blackdown Tableland and on the Expedition and Dawson Ranges running south from there, also found on the Shotover and Bedourie Ranges (Fig. 81). An early collection of this species in NSW (*MacMahon NSW 302264*, May 1906) records a locality of 'east of Rockhampton, near seacoast', but this has not been corroborated and is almost certainly an error. Locally abundant, but scattered, on sandy soil over rocky sandstone ridges, often in association with *Angophora leiocarpa*.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 21 examined): Queensland: 61 miles [c. 100 km] S of 'Bauhinia Downs' on Taroom road, *Brooker 4839*, 23 Apr 1975 (CANB, NSW); N edge of Blackdown Tableland, *Blaxell 891 & Johnson*, 27 Nov 1972 (NSW); 20.4 km from Capricorn Highway on road to Blackdown Tableland, *Hill 3603 & Stanberg*, 6 Dec 1988 (NSW); loop road between Spring Creek and Charlevue Lookout, Blackdown Tableland National Park, *Blaxell 89/202, Johnson & D'Aubert*, 7 Aug 1989 (NSW, BRI); Shotover Range, 60 miles [96 km] ENE of Springsure, *Lazarides & Story 83*, 5 Sep 1961 (CANB, NSW); 1 km along Oilbore Road towards Robinson Gorge, *Bean 275*, 5 Sep 1985 (BRI, NSW).

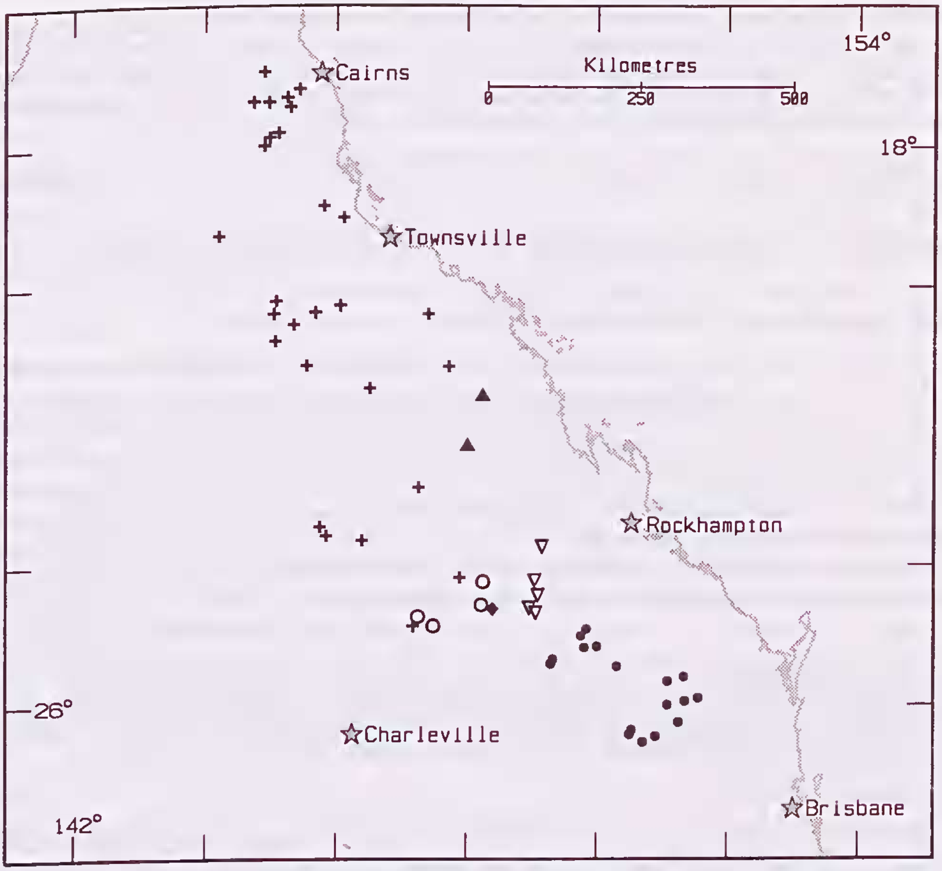

Fig. 82. Distribution of *C. leichhardtii* (plus), *C. aureola* (solid triangle), *C. catenaria* (circle), *C. watsoniana* subsp. *watsoniana* (solid circle), *C. watsoniana* subsp. *capillata* (inverted triangle), *C. catenaria – C. watsoniana* subsp. *capillata* (diamond).

74. ACOYYJ **Corymbia aureola** *(Brooker & A.R. Bean) K.D. Hill & L.A.S Johnson*, **comb. nov.**

Basionym: *Eucalyptus aureola* Brooker & A.R. Bean, Austrobaileya 3(3): 430 (1991).

Type: Queensland: Leichhardt: hills W of Lake Elphinstone, Carborough Range, *M.I.H. Brooker 10212*, 20 May 1989 (holo BRI; iso CANB, NSW).

Tree to 15 m. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* soon disjunct, setose with bristle-glands, suborbicular to ovate, soon peltate, to 10 cm long, to 50 mm wide. *Intermediate leaves* sparsely setose to bristle-free, ovate-lanceolate to lanceolate, peltate or upper ones non-peltate, to 15 cm long, to 50 mm wide. *Adult leaves* disjunct, amphistomatic and concolorous, ± glossy, lanceolate to broad-lanceolate, acuminate, 12–19 cm long, 14–40 mm wide; *petioles* 17–30 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, ± obscured. *Umbellasters* 7-flowered; *peduncles* 17–26 mm long; *pedicels* 2–4 mm long. *Mature buds* scurfy-white with remnants of rubbery cuticle, ovoid; 10–12 mm long, 7–8 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, shallowly hemispherical, broadly beaked. *Fruits* globoid, without broken-down cuticle, 13–15 mm long, 10–12 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Not recorded.

Distinguished by the subsessile, relatively large buds and fruits, and by the frequently 'glaucous' buds. This appearance is given by the degrading rubber cuticle on both hypanthium and inner calyptra; it is quite different from the waxy pruinosity frequently observed in other eucalypt groups. Adult leaves are also usually somewhat glossy.

C. aureola is a restricted species, known only from sandstone ranges around Lake Elphinstone, from the Leichhardt and Carborough Ranges through to the Cherwell Range (Fig. 82). It generally occurs on skeletal soils on slopes.

The epithet should be pronounced 'awREEola', with the stress on the second syllable.

Conservation status: 2K.

Specimens examined: Queensland: 5.8 km from Nebo to Glendon road on Coolon road, *Hill 4663, 4664, Stanberg & Coveny*, 2 July 1994 (NSW, BRI, CANB); 84 km E [NE] from Clermont on Mackay road, *Brooker 5330*, 30 July 1976 (CANB, NSW); 81 km E [NE] from Clermont on Mackay road, *Brooker 5328*, 30 July 1976 (CANB, NSW).

75. ACOYYL **Corymbia petalophylla** *(Brooker & A.R. Bean) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus petalophylla* Brooker & A.R. Bean, Austrobaileya 3(3): 428 (1991).

Type: Queensland: Burnett: Beeron Holding, 5 km W of 'Toondahra' homestead (29°59'S, 151°21'E), *A.R. Bean 1112 & P.I. Forster*, 9 Sep 1989 (holo BRI; iso A, CANB, DNA, HO, MEL, NSW, PERTH, QRS).

Tree to 15 m. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* opposite for c. 3 pairs, then disjunct, setose with bristle-glands, peltate at next few nodes. *Intermediate leaves* disjunct, soon becoming bristle-free, narrow-ovate to suborbicular, acute to obtuse, peltate early, later ones non-peltate, to 18 cm long, 100 mm wide; *petioles* to 15 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, dull, grey-green, lanceolate to broad-lanceolate, acuminate, 8–15 cm long, 17–35 mm wide; *petioles* 10–25 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, obscured by epidermis. *Umbellasters* 7-flowered; *peduncles* 10–23 mm long; *pedicels* 1–5 mm long. *Mature buds* green (non-scurfy), ovoid; 6–8 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 10–13 mm long, 9–11 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Sep.

Distinguished by the dull, grey-green, large and relatively broad adult and juvenile leaves with long petioles, and by the small to medium-sized fruits. Intermediate leaves are very large, ovate, distinctly bluish and non-bristly. Juvenile to intermediate leaves are peltate only for about 3–6 nodes between nodes 3 and 10.

Scattered and sporadic in distribution, on shallow gritty soils on granite in rolling low hill country in the Mundubbera–Eidsvold district (Fig. 81).

Conservation status: 2K.

Although it is from the same Greek root, the epithet does not refer to petals but to the broad, outspread leaves, as made clear by the authors.

Selected specimens (from 7 examined): Queensland: c. 1 km N of Eidsvold to Cracow road, 20 km W of Eidsvold, *Blaxell 89/242, Johnson & D'Aubert*, 11 Aug 1989 (NSW, BRI); Little Morrow Ck, 1 km N of road, *Hill 4332 & Noble*, 7 Nov 1992 (NSW, BRI, CANB); Washpool Creek, Eidsvold, *Bancroft*, Dec 1912 (BRI, NSW 302194); sacred mountain, 'Munboree' [Munboorie] station, via Gayndah, *Brooker 9763, 9764, 9765*, 10 Oct 1987 (CANB, BRI, NSW); 8 km W of 'Manar' homestead, *Forster 4640*, 4 Aug 1988 (BRI, CANB, NSW).

76. ACOYYN **Corymbia catenaria** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species sectionis *Ochrariae* combinatione sequenti characterum inter eos *C. leichhardtii* et *C. watsonianae* intermediorum distinguitur: fructus mediocres ad majusculi, folia adulta longe petiolata, folia juvenilia intermediaque plusminusve peltata.

Type: Queensland: 10 miles [16 km] from Springsure on Rolleston road, *D.F. Blaxell 963 & L.A.S. Johnson*, 28 Nov 1972 (holo NSW).

Tree to 15 m. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* soon disjunct, ± peltate at later nodes, not seen at all stages. *Intermediate leaves* disjunct, setose at lower nodes but bristle-free at later nodes, broad-lanceolate to ovate, acute to obtuse, subpeltate at earlier nodes, then non-peltate, to 25 cm long, 80 mm wide; *petioles* to 20 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, dull, grey-green, lanceolate to broad-lanceolate, acuminate, 9–20 cm long, 15–32 mm wide; *petioles* 18–30 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, obscured by epidermis. *Umbellasters* 7-flowered; *peduncles* 7–21 mm long; *pedicels* 1–5 mm long. *Mature buds* green (non-scurfy), ovoid; 8–11 mm long, 6–8 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical, apiculate, broader than hypanthium. *Fruits* globoid, sometimes verrucose, without broken-down cuticle, 15–21 mm long, 11–16 mm diam.; 3-locular; *disc* c. 3 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–4 mm long, 1.5–3 mm wide. Fig. 83.

Flowering: Not recorded.

Distinguished by the medium-sized to large fruits, the large, dull adult leaves with long petioles, and the peltate juvenile and intermediate leaves. Adult leaves are relatively narrower than those of *C. watsoniana*, fruits are smaller, and peduncles and pedicels shorter (see key for comparative dimensions).

Locally abundant but sporadic, on shallow sandy soils in sandstone range country around Springsure and south and west of there as far as Salvator Rosa National Park (Fig. 82).

C. catenaria is intermediate in most features between *C. leichhardtii* (which occurs to the west and north) and *C. watsoniana* (which occurs to the east and south), and probably originated as an intergrade. Populations are now, however, internally consistent and relatively uniform over the range cited above, and can be treated as constituting a hybridogenous species, in which some clinal increase in fruit size is discernible from west to east. *C. leichhardtii* is also now more or less sympatric in the Salvator Rosa region (though perhaps with some site distinction; this needs confirmation).

Brooker and Bean (op. cit.) include some material of *C. catenaria* in their concept of *E. watsoniana* subsp. *capillata*, together with material that we regard as intermediate between the latter and *C. catenaria* (Appendix 1). We consider 'pure' subsp. *capillata* (q.v.) to be restricted to the Expedition Range.

Hybrids are recorded with *C. citriodora* of section *Politaria* (Appendix 1).

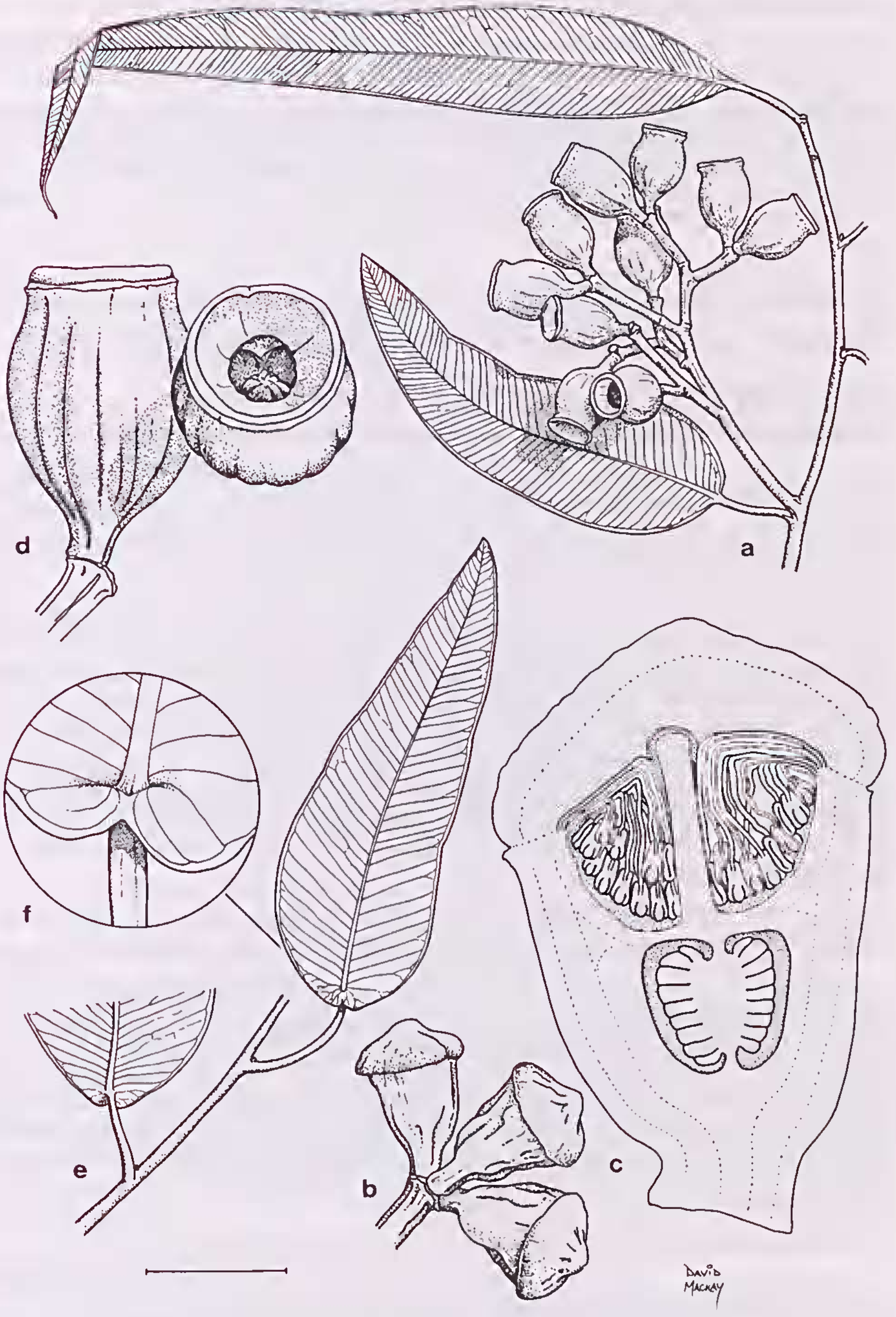

Fig. 83. *C. catenaria*. a, adult leaves, inflorescence and fruits. b, buds. c, section of bud. d, fruits. e, juvenile leaves. f, detail of juvenile leaf base (a, d from *Blaxell 89/034 et al.*, b, c, e, f from *Guymer 1145*). Scale bar: a, e = 3 cm; b, d = 1 cm; f = 6 mm; c = 3 mm.

Conservation status: 2K.

The epithet is from the Latin *catena*, a chain, and *-arius*, of the nature of, from the connection that this species forms, in a sense, between *C. leichhardtii* and *C. watsoniana*.

Selected specimens (from 12 examined): Queensland: 14.2 miles [c. 23 km] from Springsure towards Rolleston, *Brooker 4829*, 22 Apr 1975 (CANB, NSW); 22.5 km SE of Springsure, *Guymer 1145*, 6 Sep 1977 (BRI, NSW); 18.9 km SE of Springsure on Rolleston road, *Blaxell 89/034*, *Johnson & D'Aubert*, 24 July 1989 (NSW); 23 miles WSW of Rolleston, *Lazarides & Story 24*, 31 Aug 1961 (CANB, NSW); Salvator Rosa National Park (24°49'S 147°12'E), *Thomas 242*, 20 Sep 1987 (BRI, NSW).

77. ACOYYO **Corymbia watsoniana** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus watsoniana* F. Muell., Fragm. Phytogr. Austral. 10: 98 (1877).

Type citation: 'In montibus prope Wigton; Th. Wentworth Watson.'

Type: Queensland: in mountains near Wigton, *T.W. Watson* (holo MEL; iso K).

Tree to 15 m or sometimes more. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* disjunct after node 2–3, setose with bristle-glands, elliptical to ovate, to 5 cm long, to 30 mm wide, non-peltate or some later ones becoming peltate. *Intermediate leaves* disjunct, bristle-free to setose, broad-lanceolate to suborbicular, acute to obtuse, peltate or non-peltate, to 20 cm long, to 100 mm wide; *petioles* to 20 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, dull to semi-glossy, broad-lanceolate to ovate, acuminate, 9–20 cm long, 22–55 mm wide; *petioles* 13–40 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, obscured. *Umbellasters* 3–7-flowered; *peduncles* 12–35 mm long; *pedicels* 6–13 mm long. *Mature buds* green (non-scurfy), ovoid; 12–20 mm long, 10–16 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 20–32 mm long, 18–26 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Distinguished by the dull, greyish adult leaves, the large buds with the broadened calyptra extending beyond the hypanthium, and the very large fruits (for the section).

C. watsoniana is unusual in that it is more or less sympatric with three other yellow bloodwood species, *C. bunites*, *C. petalophylla* and *C. bloxsomei*. No intergradation or clear example of hybridism has been observed with these, although occasional hybrids are known with *C. variegata* of section *Politaria*. It is also the only member of section *Ochraria* in which simple trichomes have been observed, and then only on the hypocotyl, which in most species of the eucalypt genera does not bear hairs (or bristles) at all, although they are present in some species of *Corymbia* section *Rufaria*.

Two geographic subspecies are recognised.

1 Later juvenile and intermediate leaves non-setose, not peltate .... 77A. subsp. **watsoniana**

1* Later juvenile and intermediate leaves setose, peltate .... 77B. subsp. **capillata**

77A. ACOYYOB **Corymbia watsoniana** *(F. Muell.) K.D. Hill & L.A.S. Johnson* subsp. **watsoniana**

Intermediate leaves ± bristle-free, broad-lanceolate to suborbicular, not peltate, to 20 cm long, to 80 mm wide. *Adult leaves* broad-lanceolate to ovate, 9–20 cm long, 22–40 mm wide; *petioles* 18–35 mm long. *Peduncles* 12–28 mm long; *pedicels* 6–13 mm long. *Mature buds* 15–20 mm long, 12–16 mm diam. *Fruits* 24–32 mm long, 20–26 mm diam.

Flowering: Erratic, recorded June, Sep, Nov.

Distinguished from subsp. *capillata* by the non-peltate early leaf-stages. Adult leaves are also generally smaller, although there is a general trend from slightly larger leaves in the north of the range to smaller in the south. Buds and fruits are also slightly larger than those of subsp. *capillata.*

Locally abundant in dry sclerophyll woodland, usually on shallow sandy soils on outcropping siliceous sandstones, east and south from the Dawson Range to Mundubbera and the Barakula area (Fig. 82).

Hybrids are known with *C. variegata* of section *Politaria* (see Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 42 examined): Queensland: 32 miles [53 km] W of Theodore, *Lazarides 6924*, 7 July 1963 (CANB, NSW); Isla Gorge, c. 1 km S of lookout, *Blaxell 1539 & Armstrong*, 3 Sep 1977 (NSW, BRI, CANB); 21 miles [33 km] SE of 'Bedourie' homestead, *Speck 1841*, 14 Oct 1963 (CANB, NSW); 55 km from Taroom to Theodore road towards Glenhaughton, *Brooker 7334*, 7 Mar 1982 (CANB, NSW); 21 km from Cracow on Taroom road, *Johnson 7151 & B. Briggs*, 2 June 1971 (NSW); Delubra, Mundubbera, *Bloxsome*, Nov 1921, Apr, June 1922 (NSW 302121–3) ; 6 km W of 'Toondahra' homestead (25°59'S 151°21'E), *Bean 1111*, 9 Sep 1989 (BRI, NSW); 9.3 km N of Barakula Forest office, *Chippendale 1082 & Brennan*, 13 Sep 1974 (CANB, NSW); Ballon Forest Reserve, c. 50 km NNW of Jandowae, *Johnson*, 5 June 1959 (NSW 132493).

77B. ACOYYOC **Corymbia watsoniana** *(F. Muell.) K.D. Hill & L.A.S. Johnson* subsp. **capillata** *(Brooker & A.R. Bean) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus watsoniana* F. Muell. subsp. *capillata* Brooker & A.R. Bean, Austrobaileya 3(3): 428 (1991).

Type: Queensland: Leichhardt: 30.4 miles [50 km] E of Rolleston in Expedition Range, Queensland, *M.I.H. Brooker 4833*, 23 Apr 1975 (holo BRI; iso AD, CANB, MEL, NSW).

Intermediate leaves setose with bristle-glands, broad-lanceolate to suborbicular, ± peltate, to 15 cm long, to 100 mm wide. *Adult leaves* broad-lanceolate to ovate, 9–18 cm long, 30–55 mm wide; *petioles* 13–40 mm long. *Peduncles* 14–35 mm long; *pedicels* 6–10 mm long. *Mature buds* 12–18 mm long, 10–14 mm diam. *Fruits* 20–27 mm long, 18–23 mm diam.

Flowering: Recorded Nov.

Distinguished by the more or less persistent, scabrid-setose and peltate intermediate leaves. Adult and intermediate leaves tend to be larger and relatively broader than in the type subspecies, whereas buds and fruits are slightly smaller.

Locally abundant in dry sclerophyll woodland, usually on shallow sandy soils on steep or broken outcropping siliceous sandstones, restricted (as here circumscribed) to the Expedition Range east and north-east of Rolleston (Fig. 82). We have seen subsp. *capillata* in the field, but have not collected from it.

Intergrades with *C. catenaria* occur south-west of Rolleston and hybrids with *C. citriodora* (section *Politaria*) are known (see Appendix 1)

Conservation status: 2K.

Selected specimens (from 9 examined): Queensland: Blackdown Tableland, track off to E opposite loop road, *Brooker 10452*, 13 Mar 1990 (CANB, BRI, NSW); Planet Creek, c. 30 miles [50 km] NE of Rolleston, *Story & Yapp 298*, 30 Sep 1962 (CANB, NSW); Expedition Range, 30 miles [50 km] ESE of Rolleston, *Pedley 2797*, 14 Nov 1968 (BRI, NSW).

78. ACOYYQ **Corymbia dimorpha** *(Brooker & A.R. Bean) K.D. Hill & L.A.S. Johnson*, **comb. et stat. nov.**

Basionym: *Eucalyptus peltata* Benth. subsp. *dimorpha* Brooker & A.R. Bean, Austrobaileya 3(3): 418 (1991).

Type: Queensland: North Kennedy: 2.2 km N of railway line between Laroona and Ewan, *M.I.H. Brooker 10196*, 19 May 1989 (holo BRI; iso CANB, DNA, MEL, NSW).

Tree to 15 m. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* opposite, becoming ± disjunct at about node 10, setose with bristle-glands ovate-lanceolate to lanceolate, peltate after the first few nodes, to 9 cm long, to 28 mm wide. *Intermediate leaves* disjunct, setose, ovate to suborbicular, later narrower, acute to obtuse, peltate, some produced in the canopy, to 8 cm long, 100 mm wide; *petioles* to 18 mm long. *Adult leaves* disjunct, scabrid or setose to bristle-free, amphistomatic and concolorous, ± glossy, green, broad-lanceolate to ovate, acute to acuminate, 9–15 cm long, 14–45 mm wide; *petioles* 13–35 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, obscured. *Umbellasters* 7-flowered; *peduncles* 6–9 mm long; *pedicels* 0–3 mm long. *Mature buds* scurfy-white with remnants of rubbery cuticle, ovoid; 7–8 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 9–12 mm long, 8–10 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Not recorded.

Distinguished by the presence of both scabrid-setose peltate leaves and bristle-free non-peltate leaves in the mature canopy, together with the relatively small fruits, which are often distinctly pedicellate.

C. dimorpha occurs to the west of Townsville, from Laruna to the Hervey Range, and sporadically west to the Gregory Range and north to near Conjuboy (Fig. 84). It forms a mosaic with both *C. leichhardtii* (more to the east) and *C. peltata* (in drier country to the west). Although occurring in generally uniform stands, it is morphologically intermediate between the latter two species in all respects, and is reasonably treated as a hybridogenous species of this origin, having become stabilised. It is equally close morphologically to both *C. leichhardtii* and *C. peltata*, and we therefore do not accept it as a subspecies of the latter. Limited intergrading populations occur with both *C. peltata* and *C. leichhardtii* (see Appendix 1). Some trees referred to *C. dimorpha* may represent independent hybridisation of *C. leichhardtii* and *C. peltata*, but eastern populations at least are consistent.

An intersectional hybrid with *C. dallachiana* (section *Blakearia*) is of significance (see Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

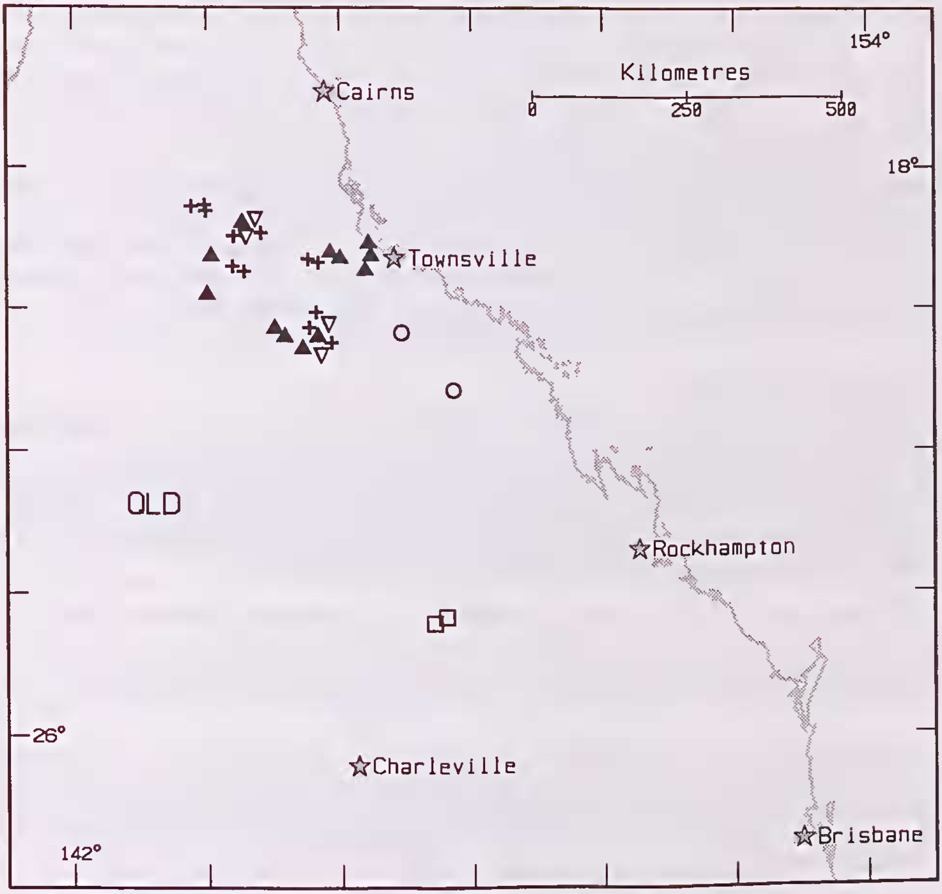

Fig. 84. Distribution of *C. dimorpha* (solid triangle), *C. peltata* (cross), *C. scabrida* (square), *C. dimorpha – C. peltata* (open triangle), *C. dimorpha – C. leichhardtii* (circle).

Selected specimens (from 18 examined): Queensland: 12 miles [c. 20 km] from Conjuboy on Hughenden road, *Brooker 4139*, 26 Aug 1973 (CANB, NSW); west face, Ben Lomond, *Jackes*, 30 Nov 1977 (NSW); 32 km from Charters Towers to Greenvale road on Ewan road, *Hill 3594 & Stanberg*, 5 Dec 1988 (NSW, BRI, CANB); 33.3 km from Bruce Highway on road to Tabletop, *Brooker 10208*, 19 May 1989 (CANB, BRI, NSW); 'Chudleigh Park' Station, southern Gregory Range, upper Stawell River, *Hill 3728 & Stanberg*, 29 July 1990 (NSW, BRI, CANB); 60 km N of Pentland on road to Wando Vale, *Blaxell 1554 & Armstrong*, 6 Sep 1977 (NSW, BRI, CANB); 27 km from Ravenswood towards Burdekin Falls, *Hill 3707 & Stanberg*, 22 July 1990 (NSW, BRI, CANB); Flinders Highway, 30 km NE of Pentland, *Rodd 4554 & Hardie*, 25 Apr 1985 (NSW, BRI, CANB).

79. ACOYYR **Corymbia peltata** *(Benth.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus peltata* Benth., Fl. Austral. 3: 254 (1867).

Type citation: 'Queensland. Porphyritic Mountains, Newcastle range, F. Mueller.'

Type: Queensland: Newcastle Ranges, *F. Mueller*, Oct 1856 (holo K; iso MEL, NSW).

[*E. melissiodora* auct. non Lindl. (1848); F. Muell., J. Linn. Soc., Bot. 3: 95 (1859)].

Tree to 15 m. *Bark* persistent throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* not seen. *Intermediate leaves* disjunct, amphistomatic and concolorous, green, setose, ovate to suborbicular, obtuse to rounded, peltate, to 12 cm long, 90 mm wide; *petioles* to 12 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, dull green, setose, ovate to suborbicular, obtuse to rounded, mostly or all peltate, 6–13 cm long, 35–100 mm wide; *petioles* 10–20 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, obscured. *Umbellasters* 7-flowered; *peduncles* 8–17 mm long; *pedicels* 0–1 mm long. *Mature buds* scurfy-white with remnants of rubbery cuticle, ovoid; 7–8 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, 10–14 mm long, 9–12 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Not recorded.

Distinguished by the mature canopy consisting of long-petiolate, broad, largely or all peltate leaves persistently setose with stiff bristle-glands. The similar *C. scabrida* from farther south has relatively narrower crown leaves with shorter petioles, and the partly broadly sympatric *C. dimorpha* has some to many non-peltate and non-setose crown leaves, and the petioles are generally longer. Intergrading populations occur in some contact areas with *C. dimorpha* (see Appendix 1).

Locally abundant, usually on very shallow soils on siliceous substrates, from the Newcastle Range south-east to the Burra Range, and east to the Clarke River (Fig. 84).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 15 examined): Queensland: 23 km W of Einasleigh on the Forsayth road, *Benson 827*, 18 June 1974 (NSW); Newcastle Ranges, 15 miles [24 km] SE of Einasleigh township, *Speck 4708*, 13 July 1954 (CANB, NSW); 21 km SE of Clarke River on Charters Towers road, *Benson 809*, 16 June 1974 (NSW); 29.7 km E of Pentland on Charters Towers road, *Blaxell 89/074, Johnson & D'Aubert*, 26 July 1989 (NSW).

80. ACOYYS **Corymbia scabrida** *(Brooker & A.R. Bean) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus scabrida* Brooker & A.R. Bean, Austrobaileya 3(3): 420 (1991).

Type: Queensland: Leichhardt: 12.5 km from 'Mantuan Downs' turn-off towards Springsure on Dawson Developmental Road, *M.I.H. Brooker 9778*, 14 October 1987 (holo BRI; iso CANB, MEL, NSW).

Tree to 15 m, often less. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* disjunct after very few nodes, setose with bristle-glands, orbicular to oblong-ovate, peltate after about node 8, to 8 cm long, to 55 mm wide; petioles to 15 mm long . *Intermediate leaves* disjunct, setose, ovate to suborbicular, later narrower, acute to rounded, peltate, often persisting into mature canopy, to 8 cm long, 60 mm wide; *petioles* to 10 mm long. *Adult leaves* disjunct, ± setose or scabrid with bristle-glands, amphistomatic and concolorous, dull, broad-lanceolate or narrow-elliptical to ovate or oblong, apiculate to rounded, peltate or non-peltate in later stages, 6–12 cm long, 16–35 mm wide; *petioles* 7–16 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, not obscured. *Umbellasters* 7-flowered; *peduncles* 8–20 mm long; *pedicels* 1–2 mm long. *Mature buds* ± scurfy-white with remnants of rubbery cuticle, ovoid; 7–8 mm long, 5–6 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, often verrucose, 9–11 mm long, 8–10 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Recorded Oct.

Distinguished by the relatively narrow, persistently scabrid-setose but not always peltate leaves with short petioles in the mature canopy. Adult leaves are not always peltate as they are stated to be by Brooker & Bean (op. cit.), and the 'non-glaucousness' of the buds mentioned by those authors is also not complete, being merely a lesser degree of the breakdown of the rubbery cuticle in contrast to the condition in *C. peltata.*

A fairly abundant species over a relatively small area on skeletal sandy soils on sandstone ridges in country west of Springsure (Fig. 84).

Conservation status: Although locally abundant, this species is known only from a small area.

Selected specimens (from 8 examined): Queensland: 10.8 miles [c. 18 km] from Nandowrie towards Nardoo, *Brooker 4891*, 30 Apr 1975 (CANB, NSW); 8 miles [c. 13 km] E of 'Mantuan Downs' station, *Adams 1374*, 14 Oct 1964 (CANB, NSW); 11 km E of 'Mantuan Downs' turnoff on Springsure to Tambo road, *Blaxell 1492 & Armstrong*, 31 Aug 1977 (NSW, BRI, CANB); 80.9 km W of Springsure on Tambo road, *Hill 1195, Johnson & Bean*, 22 Aug 1984 (NSW, BRI, CANB, PERTH).

81. ACOYYX **Corymbia eximia** *(Schauer) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus eximia* Schauer in Walp., Rep. Bot. Syst. 2: 925 (1843).

Type citation: 'In Nova Hollandia olim leg. Ferd. Bauer.'

Type: New South Wales: banks of the Grose River, *R. Brown & Ferd. Bauer (Bennett 4776)*, Sep-Oct 1803 (holo W; iso BM, E, K, NSW).

= ? *E. elongata* Link, Enum. Hort. Berol. 2: 30 (1822), nom. dubium.

Type citation: 'Hab. in Australia h. T.'

Type: Maiden (Crit. Rev. Eucalyptus 5: 28, 1920) stated that 'a specimen in the Vienna herbarium labelled "*Eucalyptus elongata* Link, Ferd. Bauer", is *E. eximia* Schau.' Maiden (loc. cit.) also recorded the application of the name *E. elongata* Link to various other species by Otto. Chippendale (1974) did not record the above or other specimens of *E. elongata* Link, and the name must remain a nomen dubium unless authentic type material is located, in which case it may assume priority (although measures proposed at the Tokyo International Botanical Congress to prevent displacement by resuscitation of forgotten names should preserve present usage).

Tree to 15 m or sometimes more, but several-stemmed and stunted in some exposed sites. *Bark* persistent almost throughout, soft, loosely scaly and fibrous, tessellated, yellow-brown to greyish yellow, yellow to orange on freshly broken surfaces. *Juvenile leaves* disjunct after node 2–3, setose with bristle-glands, elliptical to ovate, peltate after node 5, to 8 cm long, to 50 mm wide; *petioles* to 14 mm long. *Intermediate leaves* disjunct, bristle-free, broad-lanceolate, falcate, acuminate, non-peltate, to 25 cm long, 55 mm wide; *petioles* to 35 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, dull grey-green, lanceolate to broad-lanceolate, often falcate, acuminate, 12–20 cm long, 14–30 mm wide; *petioles* 12–28 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular, frequently not obscured. *Umbellasters* 7-flowered; *peduncles* 10–30 mm long; *pedicels* 0–2 mm long. *Mature buds* green (non-scurfy), ovoid; 9–14 mm long, 5–7 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid, without broken-down cuticle, sometimes

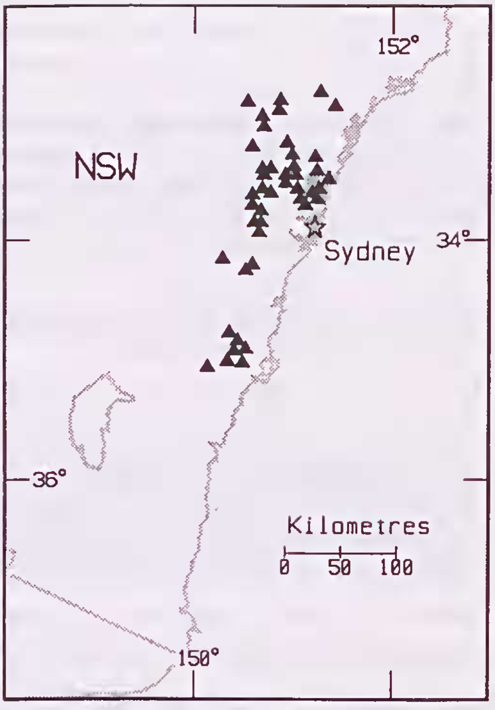

Fig. 85. Distribution of *C. eximia*.

somewhat verrucose 14–21 mm long, 9–15 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Sep–Oct.

Distinguished by the dull, greyish, markedly falcate adult and intermediate leaves, and the relatively large subsessile fruits. The bark is less yellow and rather more compact than in many of the Queensland species.

Locally abundant on skeletal soils on siliceous sandstone, in eastern New South Wales from Pokolbin to the lower Shoalhaven River, mainly on dryish sites away from the immediate coast, generally below 500 m altitude (Fig. 85).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 90 examined): New South Wales: North Coast: Hunter Valley, Broken Back Range, between Pokolbin and Broke, ridge above Francois Vineyard, *Slee 2321*, 19 Oct 1988 (CANB, BRI, MEL, NSW). Central Coast: 1 mile [1.6 km] N of Howes Valley, *Constable*, 27 Aug 1957 (NSW 46255); Staircase Hill, quarry on E side of road at crest of hill near entrance to High Wollemi property, 77 km N of Wilberforce on the Windsor to Singleton road, *Coveny 15439 & Leishman*, 8 Aug 1991 (NSW, BRI, CBG, HO, MEL); Mangrove Mtn, *Gregson*, 9 May 1953 (NSW 302525); Lower Gospers Ck, *Hind*, 10 Oct 1976 (NSW 30525); 6.8 km from Glenorie to Wisemans Ferry road towards Sackville, *Chippendale 1014 & Godenzi*, 29 May 1974 (CANB, NSW); Cowan, *Johnson, 18 Aug 1948 (NSW 6491)*; Galston, *Morris*, 3 Oct 1924 (NSW); Springwood, *Boorman*, Dec 1900 (NSW); Nortons Basin, W of Wallacia, *Coveny 11936, Bishop & Goodwin*, 16 Oct 1984 (NSW, CANB, CBG, K, PERTH); Beloon Trig Station, Nattai, *A. Mitchell 319*, 10 Mar 1965 (NSW); Blue Gum Ck, about 2 miles [3 km] SW of Picton Lakes (SW of Thirlmere), *Johnson*, 27 Mar 1959 (NSW 302550); 20.3 km from Kangaroo Valley towards Tallowa Dam, *Hill*

3619, 7 Nov 1989 (NSW, CANB MEL); South Coast: Burrier, 10 miles [16 km] W of Nowra, *Constable*, 26 Feb 1960 (NSW); 2 km N of Danjera Ck, *Johnson 3138, Blaxell & B. Briggs*, 18 Dec 1969 (NSW); 4 miles (6.5 km) W of Ettrema Creek on track to Tolwong, *Campbell 1345 & Pickard*, 27 Dec 1970 (NSW).

ACQ Section Cadagaria

Rhizomes not recorded. Bark smooth. Simple hairs absent. Juvenile leaves peltate at some stages. Adult leaves amphistomatic, discolorous. Mesophyll fibres absent. Inflorescence ± terminal. Umbellasters 7-flowered. Calyx calyptriform, membranous, shedding early. Corolla calyptriform, not thickened. Style bent near tip in bud, tip not engaged in calyptra. Stigma tapered, with short papillae. Columella not present in open fruits (abscising at base on fruit dehiscence). Seeds dorsiventrally compressed, wingless, smooth, with reticulate cracking in testa.

Juvenile leaves are distinctive in becoming disjunct at a very early stage (before node 3), although this is matched in some species of sections *Ochraria* and *Politaria*, and also in not developing thickened petioles. The section is also unusual in that the open fruits lack the persistent central columella that occurs in all other bloodwood groups. A central structure is present in buds and developing fruits, but it abscises at the base immediately the fruits open, and is shed with the seeds. This condition is clearly apomorphic.

The bark, both smooth and rough, is also unlike that in most other sections, and most resembles that of section *Blakearia*. Smooth bark sheds in thin, large sheets rather than small polygonal scales; rough bark is hard, shortly fibrous and grey to black.

In some ways, section *Cadagaria* may be similar to a putative ancestor of the augmented yellow bloodwood group, especially in its habitat marginal to rainforest, but it does possess some apparent apomorphies such as the amphistomatic leaves and the bent style. It is noteworthy as forming occasional hybrids with species of both section *Politaria* and section *Blakearia*; no opportunity exists at present for it to hybridise spontaneously with any member of section *Ochraria*.

A unispecific section, restricted to a small, high-rainfall tropical region in north-eastern Queensland (Fig. 17). The sectional epithet refers to the Aboriginal-derived vernacular name, 'Cadaga' or 'Cadagi', of the sole species. It is of interest that species of the related yellow bloodwoods have been called by similar names of Aboriginal origin.

Both Bentham (1867) and Maiden (Crit. Revis. Eucalyptus 6: 525–537, 1923) placed the single species (as *Eucalyptus torelliana*) with the *Corymbosae*. Blakely (1934) included it in subseries *Ochrophloiae* with the yellow bloodwoods, and Blake (1953) placed it in the *Corymbosae* with all other bloodwoods. Pryor and Johnson (1971) separated it in a monotypic series within section *Ochraria*, the latter also including the yellow bloodwoods and the spotted gums. Chippendale (1988) accepted the three series proposed by Pryor and Johnson in their section *Ochraria*. Carr and Carr (1988) placed *E. torelliana* with the spotted gums (section *Politaria* herein).

82. ACQUUT **Corymbia torelliana** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus torelliana* F. Muell., Fragm. 10: 106 (1877).

Type citation: 'Prope portum Trinity-Bay; Fitzalan.'

Type: Queensland: near Trinity Bay, *Fitzalan* (holo MEL).

Tree to 30 m. *Bark* persistent for 1–2 m on lower trunk only, dark grey, scaly and ±

tessellated; smooth above, grey-green to whitish green, shedding in thin sheets. *Cotyledons* 5–6 mm long, 6–8 mm wide; *petioles* to 4 mm long. *Juvenile leaves* disjunct after node 2–3, setose with bristle-glands, elliptical to ovate, peltate after node 5, to 7 cm long, to 50 mm wide; *petioles* to 17 mm long. *Intermediate leaves* disjunct, bristle-free, narrow-ovate to suborbicular, acute to obtuse, peltate, to 17 cm long, 90 mm wide, often persisting in canopy to flowering; *petioles* to 18 mm long. *Adult leaves* disjunct, amphistomatic, discolorous, very glossy above, acuminate, narrow-lanceolate to lanceolate, 8–15 cm long, 14–42 mm wide, frequently not developed in otherwise adult plants; *petioles* 15–24 mm long; *intramarginal vein* distinct; *oil glands* large, regularly distributed. *Umbellasters* 7-flowered; *peduncles* 7–15 mm long; *pedicels* 0–5 mm long. *Mature buds* ovoid; 10–12 mm long, 5–8 mm diam.; *calyptra* 1/4–1/2 as long as hypanthium, conical to hemispherical. *Fruits* globoid, 8–11 mm long, 8–12 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Aug–Oct.

A distinctive and isolated species, readily distinguished from all other bloodwoods by the combination of distinguishing characters discussed above for the section. The development of foliage of fully adult form is generally late, and varies from considerable to none at all, both in natural occurrences and in cultivation.

Restricted to rainforest margins or wet sclerophyll forests on deep, relatively rich soils in the high-rainfall regions from near Cooktown south to the eastern slopes of the Atherton Tableland (Fig. 86). *C. torelliana* is widely cultivated for amenity purposes in warm regions outside its natural area, and occasionally locally established adventively in such places in Queensland.

Intersectional hybrids, of great interest in linking the bloodwood groups, are known with *C. henryi* (section *Politaria*) and *C. tessellaris* (section *Blakearia*). See Appendix 1.

Conservation status: Locally abundant over an area of moderate extent, not considered to be at risk.

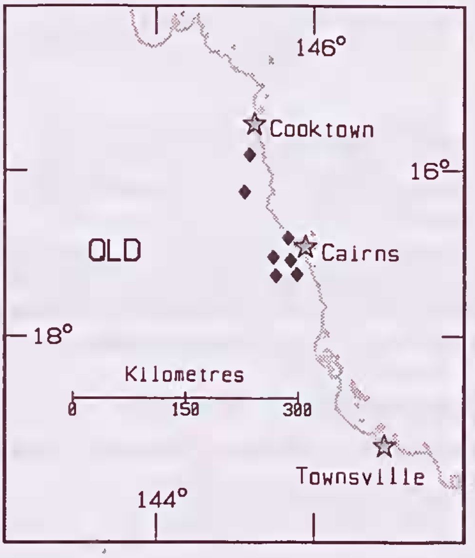

Fig. 86. Distribution of *C. torelliana*.

Selected specimens (from 22 examined): Queensland: Cook: S.F.R. 144, Windsor Tableland (16°15'S 145°05'E), *Hyland 5570*, 7 Oct 1971 (QRS, NSW); W of Kuranda, *Johnson*, 22 May 1962 (NSW); Little Mulgrave River (17°05'S 144°40'E), *Irvine 1192*, 18 Feb 1975 (QRS, NSW); Atherton, *Mocatta 14*, Dec 1915 (NSW).

ACS Section **Politaria**

Rhizomes not recorded. Bark smooth. Juvenile leaves peltate and cordate with long petioles except in the first 2–4 nodes, setose with bristle-glands but lacking simple hairs (a few simple hairs may be present on the hypocotyl, at least in *C. maculata*, as seen in some yellow bloodwoods such as *C. watsoniana*). Adult leaves concolorous, amphistomatic. Mesophyll fibres absent. Umbellasters 3-flowered, borne in raceme-like inflorescences that are usually axillary to foliage leaves. Calyx calyptriform, not membranous, persistent to near anthesis. Corolla calyptriform, not thickened. Style in bud straight or sometimes incipiently and inconstantly bent, tip not engaged in calyptra. Stigma shaggy, with short papillae. Columella present in open fruits. Seeds wingless, smooth, with reticulate cracking in testa.

Both Bentham (1867) and Maiden (1923) included the spotted gums in *Corymbosae*. Blakely (1934) placed them in subseries *Maculatae*, and Blake (1953) placed them in the *Corymbosae* with all other bloodwoods. Pryor and Johnson (1971) separated them as a separate series within section *Ochraria*, which also included *E. torelliana* and the yellow bloodwoods as another two distinct series. Chippendale accepted the three series in this group proposed by Pryor and Johnson. Carr and Carr (1988) placed the spotted gums and *E. torelliana* in a separate series, which together with a series encompassing the yellow bloodwoods constituted a section equivalent to section *Ochraria* of Pryor and Johnson.

Four closely related species are recognised in the section, from subtropical and upland tropical regions in eastern Queensland southward, becoming mainly coastal or sub-coastal in New South Wales and with a small outlying occurrence in far eastern Victoria (Fig. 17).

The sectional epithet is from the Latin, *politus*, made smooth or polished. This is the only section of *Corymbia* in which all species have smooth (decorticating) bark throughout.

It has been customary to recognise two species, or more recently three (including *C. henryi*), among the spotted gums, although this has been questioned by persons familiar with at least some of the populations, and in a thoughtful and useful study by Larsen (1965).

In particular, it has been perceived that of the populations referred to *Eucalyptus maculata* (as distinct from *E. henryi* or the more northern *E. citriodora*), those from north of the Macleay River district were narrower-leaved and generally more gracile, tending to resemble *C. citriodora* but lacking the lemon scent that has been the traditional marker for that species. Larsen (l.c.) and others with forestry preoccupations have especially emphasised the 'Richmond Range Spotted Gum', for which an invalid name, '*E. grayi*', has been used in forestry circles (see below under *C. variegata*).

Four ecogeographic entities are evident from (1) study of Larsen's findings, (2) discussion with others (especially L.D. Pryor), (3) field observations through the range of section *Politaria*, and (4) the geographical distribution of characters, especially shape of juvenile leaves, thickness of adult leaves and the ratio L_{max}: B_{max} (i.e. length of longest leaf to breadth of broadest well-developed leaf on a flowering or fruiting seasonal growth unit). That there is a degree of overlap in measurements is not surprising in view of the ontogenetic changes in individual trees. Also, it is clear that there are some local variants and morphologically or physiologically detectable ecotypes (e.g.

the Richmond Range basalticolous 'form'). There are also general clinal trends throughout, but these are steepened over certain interzones (Figs. 89–91).

Three of the entities replace each other latitudinally, whereas the fourth (*C. henryi*) is broadly sympatric with the middle member (*C. variegata*) of the north–south series, but is generally ecologically separated. Certainly, as shown by the characters recorded in the following treatment (especially shape of juvenile leaves) and those in Fig. 88, it is not at all reasonable to lump the middle and southern members of the replacement series while keeping *C. citriodora* distinct, largely on the basis of a noticeable chemical difference in essential oil. The three serial entities, in the context of the complexities evident in eucalypt taxonomy generally, are at the borderline of species and subspecies.

The most useful and convenient course appears to be to recognise four species in *Politaria*, of which *C. citriodora*, *C. variegata* and *C. maculata* sensu stricto can be referred to Superspecies *Maculata*, using this extracodical category in the sense of Pryor and Johnson (1971). The fourth species, *C. henryi*, although closely related, can be excluded from this superspecies. More local ecotypes can, at least for the present, be referred to informally by vernacular names, and the two interzonal intergrading populations can be treated as intergrades in the terms of Appendix 1, with condensed-formula appellations of convenience (*C.* ig. 'citrivar', *C.* ig. 'macuvar').

83. ACSAAC **Corymbia citriodora** *(Hook.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus citriodora* Hook. in Mitchell, Trop. Austral., 235 (1848).

Type: Queensland: subtrop. New Holland [Balmy Ck], *T.L. Mitchell*, 16 July 1846 (syn K; isosyn CGE); *T.L. Mitchell 217*, 17 July 1846 (isosyn? CGE).

= *E. maculata* Hook. var. *citriodora* Bailey, Synopsis Queensland Fl. 181 (1883), no basionym or type cited. For further details of synonymy in varietal rank see Chapman (1991: 106).

= *E. melissiodora* Lindl. in Mitchell, Trop. Austral., 235 (1848).

Type: Queensland: subtropical New Holland [Balmy Ck], *T.L. Mitchell*, 16 July 1846 (holo CGE; iso K). Figured by Maiden (Crit. Rev. Eucalyptus 5, 1920).

Tree to 40 m, rarely more, trunk slender. *Bark* smooth throughout, white to pale grey, pink or cream, usually even in colour, shedding in small sheets or scales. *Juvenile leaves* disjunct after node 2–3, setose with bristle-glands, narrow-elliptical to broad-lanceolate, peltate and cordate from about node 3–5, to 12 cm long, to 50 mm wide; *petioles* to 22 mm long. *Intermediate leaves* disjunct, non-setose and non-peltate, broad-lanceolate, acute to obtuse, to 12 cm long, to 40 mm wide; *petioles* to 16 mm long. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, concolorous, amphistomatic, very glossy, acuminate, 7–22 cm long, 6–22 mm wide; *petioles* 12–22 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular. *Umbellasters* 3-flowered; *peduncles* 3–8 mm long; *pedicels* 1–6 mm long. *Mature buds* ovoid; 7–9 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical and shortly apiculate. *Fruits* globoid-urceolate to ovoid urceolate, often warty, 8–15 mm long, 7–11 mm diam.; 3-locular; *disc* c. 2 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Jan–Apr(–June).

Distinguished within the section by the relatively narrow leaves to which the aldehyde citronellal in the essential oil imparts a distinct lemon odour. As discussed above under Superspecies *Maculata*, *C. citriodora* is almost identical with at least the northern forms of *C. variegata* in morphology, distinguished only by the strong lemon scent. The lemon scent occurs consistently over the large range of distribution north of about 25°S. However, it fades to undetectability in specimens of more than 60–100 years since collection. Juvenile leaves are shown in Fig. 88b.

Locally abundant but sporadic in distribution, in dry sclerophyll or grassy forest or closed woodland on lighter to skeletal soils, often on siliceous ridges and at some elevation in the north of its range. Distributed, with some disjunctions, from south-west of Cooktown to south of Gladstone, and west to the Great Dividing Range west of Springsure (Fig. 87). The species, known as 'Lemon-scented Gum', is widely cultivated, in amenity and other plantings, in Australia and overseas.

South of Gladstone to the Maryborough district, within some 60 km of the coast, and adjoining the northern area of distribution of *C. variegata* to the west, there are intermediate populations showing variability in citronellal content and consequent strength of the lemon aroma. These are discussed by Larsen (1965) (see also Appendix 1 under *C. citriodora* – *C. variegata* intergrades). Occasional intersectional hybrids with *C. catenaria* (q.v.) and with *C. watsoniana* subsp. *capillata* (q.v.) are also known (see Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 38 examined): Queensland: Mt Janet, c. 16 km WSW of Lakeland Downs, 15°54'S 144°42'E, *Clarkson 6269*, 6 Sep 1985 (BRI, CANB, K, NSW); Herberton Range, *Hyland 5140*, 7 June 1971 (QRS, NSW); between Herberton and Irvinebank, *Brooker 3360*, 25 Jan 1972 (CANB, NSW); 11 km from Kennedy Development Road towards Gregory Springs, *Gittins 2503*, Aug 1972 (NSW); 20.8 km W of Paluma on road to Hidden Valley, *Blaxell 89/173, Johnson & D'Aubert*, 4 Aug 1989 (NSW); 12 miles [20 km] N of 'Mt Sturgeon' station, *Lazarides 3653*, 27 June 1953 (CANB, NSW); NW of 'Allandale' homestead, 20°20'S 145°32'E, *Martensz 1240*, 8 Oct 1978 (CANB, MEL, NSW); Moke Point, North Keppel Island, *Batianoff 9205 & Dillewaard*, 10 Oct 1987 (BRI, NSW); 7 miles [12 km] E of Duaringa, *Speck 1669*, 13 Aug 1963 (CANB, NSW); slopes below N escarpment of Blackdown Tableland, *Blaxell 917 & Johnson*, 28 Nov 1972 (NSW); Mt Zamia, near Springsure, *Brooker 7359*, 8 Mar 1982 (CANB, NSW); 11 km W of 'Fairview', 'Mantuan Downs' to Alpha road, *Bean 2236*, 5 Sep 1990 (BRI, NSW); Expedition Range, 27 miles[44 km] ESE of Rolleston, *Lazarides & Story 16*, 30 Aug 1961 (CANB, BRI, NSW).

84. ACSAAL **Corymbia variegata** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus variegata* F. Muell., J. Linn. Soc., Bot. 3: 88 (1859).

Type citation: 'Hab. In collibus graminosis ad flumen Burnett, Anth. aestate.'

Type: Queensland: Burnett River, *F. Mueller* (holo MEL (photo NSW); iso K). Bentham (1867) synonymised *E. variegata* with *E. maculata*, whereas Maiden (Crit. Rev. Eucalyptus 5: 90, 1920) regarded it as synonymous with *E. maculata* var. *citriodora*, and later with *E. citriodora* when noting that he considered the latter a distinct species. The holotype has recently been determined in MEL by M.I.H. Brooker as *E. maculata*. The type locality is from camp CXXXIV of Gregory's expedition of 1856, near Bouverie's Station on the Burnett River above its junction with the Boyne. This is near Mundubbera, in an area known to have the species treated hereunder, not intergrades with *C. citriodora* such as occur farther east on the Burnett (see below and Appendix 1). Mueller mentioned no lemon scent and referred to his species as being called Spotted Gum by some colonists. No lemon scent is detectable in the holotype, which still retains some general 'spotted gum' odour.

Tree to 50 m, though often less, trunk usually not exceptionally slender. *Bark* smooth throughout, creamy-white to pale grey or pink, usually even in colour, shedding in small sheets or scales, giving a spotted appearance, at least at times. *Juvenile leaves* disjunct after node 2–3, peltate and cordate from about node 5, setose with bristle-glands, ovate to ovate-lanceolate or deltoid-lanceolate, to 18 cm long, to 60 mm wide. *Intermediate leaves* non-setose and non-peltate, ovate to broad-lanceolate, acute to obtuse, to 20 cm long, to 100 mm wide; petioles to 30 mm long (often less). *Adult leaves* disjunct, narrow-lanceolate to lanceolate, amphistomatic and concolorous, glossy or semi-glossy, acuminate, 10–23 cm long, 10–28 (rarely 35) mm wide; *petiole* 10–25 mm long; *intramarginal vein* distinct; oil glands abundant, regular. *Umbellasters* 3-flowered; peduncles 4–8 mm long; pedicels 1–5 mm long. *Mature buds* ovoid, 8–11 mm long, 5–7 mm diam.; calyptra 1/4–1/3 as long as hypanthium, hemispherical and shortly apiculate. *Fruits* globoid-urceolate to ovoid-urceolate, sometimes warty, 9–15 mm long, 8–11 mm diam; 3-locular; disc 2–3 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Somewhat erratic, recorded Mar, July–Sep, Nov–Dec; prolific flowering occurs only at intervals of several years.

A species similar to *C. citriodora* and more or less intermediate between that species and *C. maculata*, distinguished by the following combination of characters; leaves and branchlets not lemon-scented (citronellal not present in large quantity); juvenile leaves with length:breadth ratio from 1.8:1 to 4:1 (Fig. 88c); adult leaves (i.e. on flowering branchlets) thin (as in *C. citriodora*), the broadest usually 13–28 mm broad (rarely to 35 mm), L_{max}:B_{max} usually from 5:1 to 12:1.

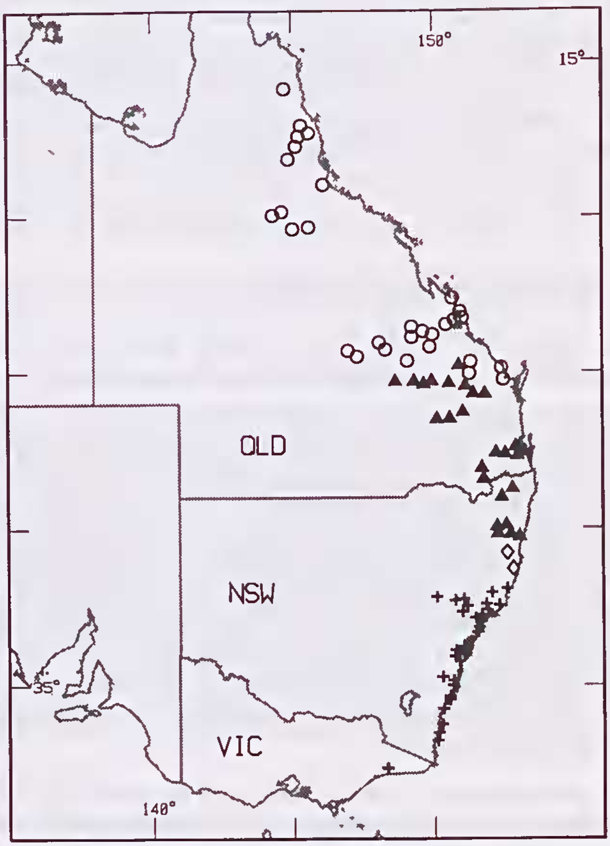

Fig. 87. Distribution of *C. citriodora* (circle), *C. variegata* (triangle), *C. maculata* (plus), *C. maculata* – *C. variegata* (diamond).

Widely ranging, from the Carnarvon Range and the Dawes Range north of Monto in Queensland, contracting southward to sub-coastal regions as far south as the upper Nymboida River and north-west of Coffs Harbour in New South Wales (Fig. 87). It occurs chiefly on soils of medium fertility, but often on hilly country.

On the Richmond Range west of Casino, *C. variegata* occurs in tall forests as a tree up to 50 metres (e.g. *Hill 4312, Johnson & Noble*, cited below), which exhibits high rates of growth when planted on good soils generally; this form probably represents one of several physiological ecotypes that show little, if any, morphological distinction. See also Larsen (1965) as *Eucalyptus maculata* 'var. *grayi*', an invalid name. Specimens from other eastern and northern parts of the range do not appear to be distinguishable from this form in its supposedly very narrow crown leaves and small fruits.

Somewhat broader-leaved trees occur, intermixed apparently in a single variable population, with narrow-leaved forms, e.g. on Herries Range west of Warwick, Queensland, (*Blaxell 89/291, Johnson & D'Aubert*, with the narrow-leaved *89/290* cited below). This does not appear to be entirely a matter of ontogenetic stage of the branchlets concerned, although reversion shoots produced after insect-caused or other damage frequently bear intermediate-type foliage and lead to the false impression that broader forms are present, even in tall trees of the Richmond Range forests. At Helidon, Queensland, specimens with adult leaves rather thicker than usual have been collected (*Smith 1408*, below), but the juvenile leaves of these are well within the range of *C. variegata* rather than the southern *C. maculata* sensu stricto. However, *C. henryi* is also known from the Helidon district, and hybridism with that species may occur there.

Intergrades and possible hybrid swarms with *C. citriodora* (q.v. and see Appendix 1) occur to the north-east of the area of *C. variegata*. Geographically and morphologically intergrading populations between *C. maculata* (q.v). and *C. variegata* (Appendix 1) occur in the Macleay River district. There appears to be some local hybridism with *C. henryi* (q.v. and Appendix 1). Intersectional hybrids occur occasionally with *C. bloxsomei* and *C. watsoniana* subsp. *watsoniana* (q.v.) of section *Ochraria* (Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 38 examined): Queensland: 45 miles SW of Theodore, *Lazarides 6932*, 7 July 1963 (CANB, NSW); 52 miles S of 'Bauhinia Downs' towards Taroom, *Brooker 4838*, 23 Apr 1975 (CANB, NSW); Carnarvon Range, 54 miles [87 km] N of Injune, *Johnson*, 15 May 1967 (NSW); 10.1 km W of Gayndah towards Mundubbera, *Chippendale 1089, 1090 & Brennan*, 14 Sep 1974 (CANB, NSW); Barakula, *McGillivray 315*, 26 Aug 1957 (NSW); Mt Coot-tha, *Johnson*, 24 May 1951 (NSW302630); 2.6 km W of Cameronian Gate on Warwick-Pikedale road along Herries Range, *Blaxell 89/290, 89/291, Johnson & D'Aubert*, 16 Aug 1989 (NSW, BRI, CANB, MEL).

New South Wales: North Coast: Peacock Creek logging area, off Cambridge Forest Drive [Richmond Range], *Hill 4312, 4313, 4314, Johnson & Noble*, 4 Nov 1992 (NSW, BRI, CANB); Girard State Forest, at crossing of highway and Girard Creek, *Hill 814 & Johnson*, 9 May 1984 (NSW); Wild Cattle Creek State Forest, 1 km S of Pine Road on logging track opposite Little River Road, *Hill 2730, Johnson & Weston*, 18 Oct 1987 (NSW, CBG, MEL, PERTH); Paddys Land State Forest, *Turner*, 10 May 1955 (NSW 302338); Nana Glen Creek, *de Beuzeville 319*, 10 Oct 1931 (NSW).

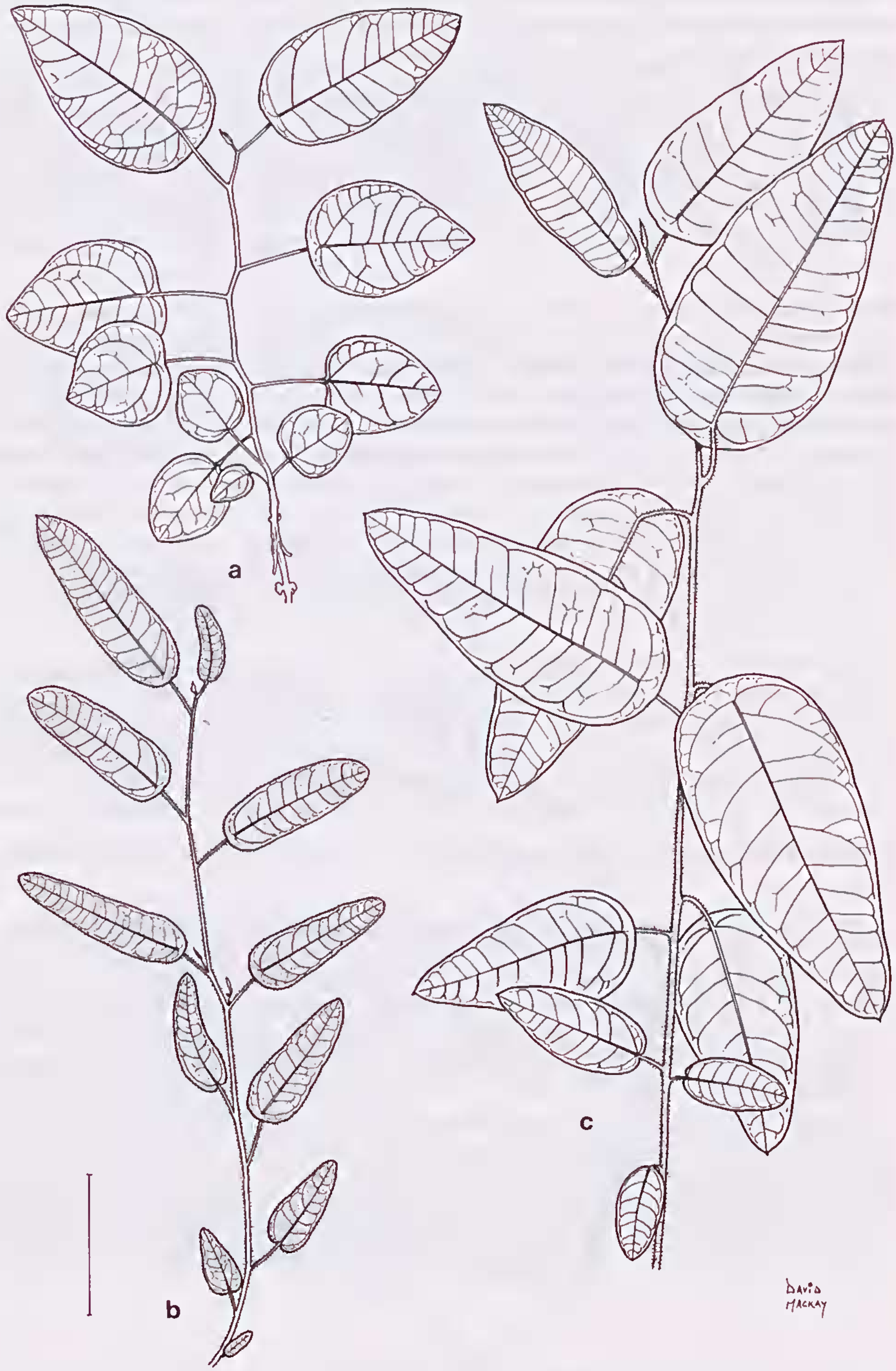

Fig. 88. Juvenile leaves of (a) *C. maculata* (grown from seed of *Willis 45*), (b) *C. citriodora* (from *Blaxell 917 & Johnson*), (c) *C. variegata* (from *Hill 4314 et al.*). Scale bar = 3 cm.

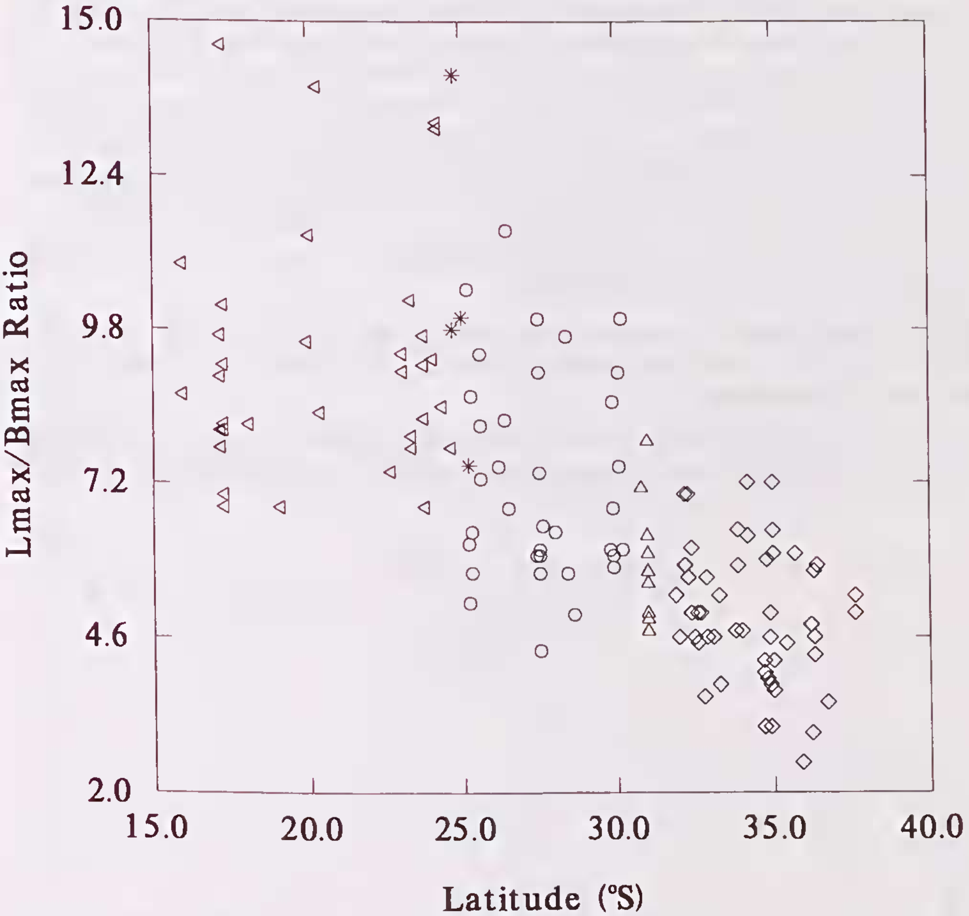

Fig. 89. Variation in superspecies *Maculata*: *C. variegata*, (circle), *C. maculata* – *C. variegata* (triangle), *C. maculata* (diamond), *C. citriodora* (sideways triangle), *C. citriodora* – *C. variegata* (asterisk).

85. ACSAAS **Corymbia maculata** *(Hook.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus maculata* Hook., Icon. Pl. 7: 619 (1844).

Type citation: 'Backh. mst. n. 37.'

Type: New South Wales: Maitland, *J. Backhouse 37*, c. 1837 (holo K; iso NSW).

Hooker specifically cited this number, although mentioning other collections in his comments on habitat. This specimen is therefore accepted as the holotype, and others mentioned may be regarded as paratypes and thus of no nomenclatural significance.

Tree to 35 m, sometimes more, trunk comparatively stout. *Bark* smooth throughout, pale grey, pink or cream, usually even in colour, shedding in small sheets or scales, giving a spotted appearance. *Juvenile leaves* disjunct after node 2–3, setose with bristle-glands and lacking simple hairs (but simple hairs at least sometimes present on hypocotyl and on cotyledon petioles) elliptical to ovate, peltate after node 3–5, to 9 cm long, to 55 mm wide; *petioles* to 20 mm long. *Intermediate leaves* disjunct, non-setose and non-peltate, ovate to broad-lanceolate, acute to obtuse, to 20 cm long, to

100 mm wide; *petioles* to 30 mm long (usually much less). *Adult leaves* disjunct, narrow-lanceolate to lanceolate or broad-lanceolate, amphistomatic and concolorous, glossy or semi-glossy, acuminate, 10–22 cm long, 12–40 mm wide; *petioles* 10–25 mm long; *intramarginal vein* distinct; *oil glands* abundant, regular. *Umbellasters* 3-flowered; *peduncles* 5–10 mm long; *pedicels* 2–7 mm long. *Mature buds* ovoid; 8–11 mm long, 5–7 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical and shortly apiculate. *Fruits* globoid-urceolate to ovoid-urceolate, 11–15 mm long, 8–11 mm diam.; 3-locular; *disc* 2–3 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–2.5 mm wide.

Flowering: Somewhat erratic, recorded May–June, Aug–Sep; prolific flowering occurs only at intervals of several years.

Distinguished within Superspecies *Maculata* by the broader juvenile leaves (Fig. 88a), and by the adult leaves having higher L_{max}:B_{max} ratios (3:1–7:1) and greater thickness (0.24–0.30 mm).

Locally an abundant species, often forming dense pure stands in tall dry sclerophyll forests on well-drained sites on moderately infertile, often shallow soils, mainly in

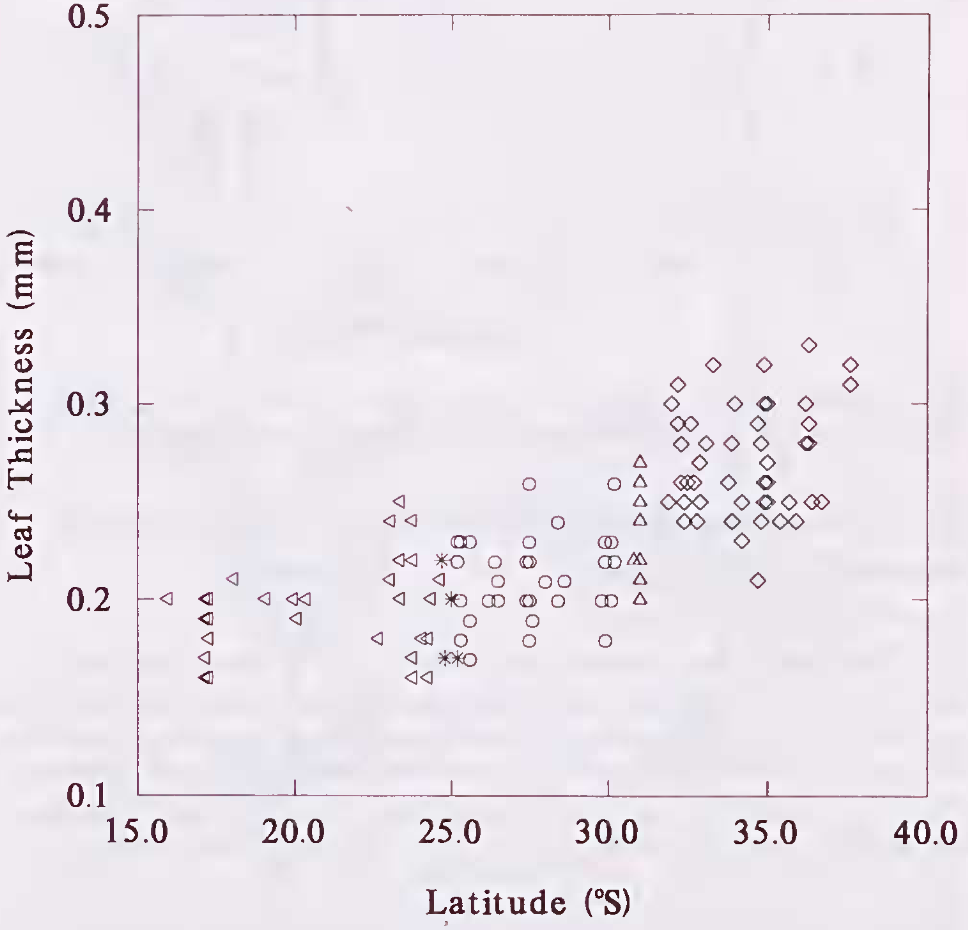

Fig. 90. Variation in superspecies *Maculata* (symbols as in Fig. 89.)

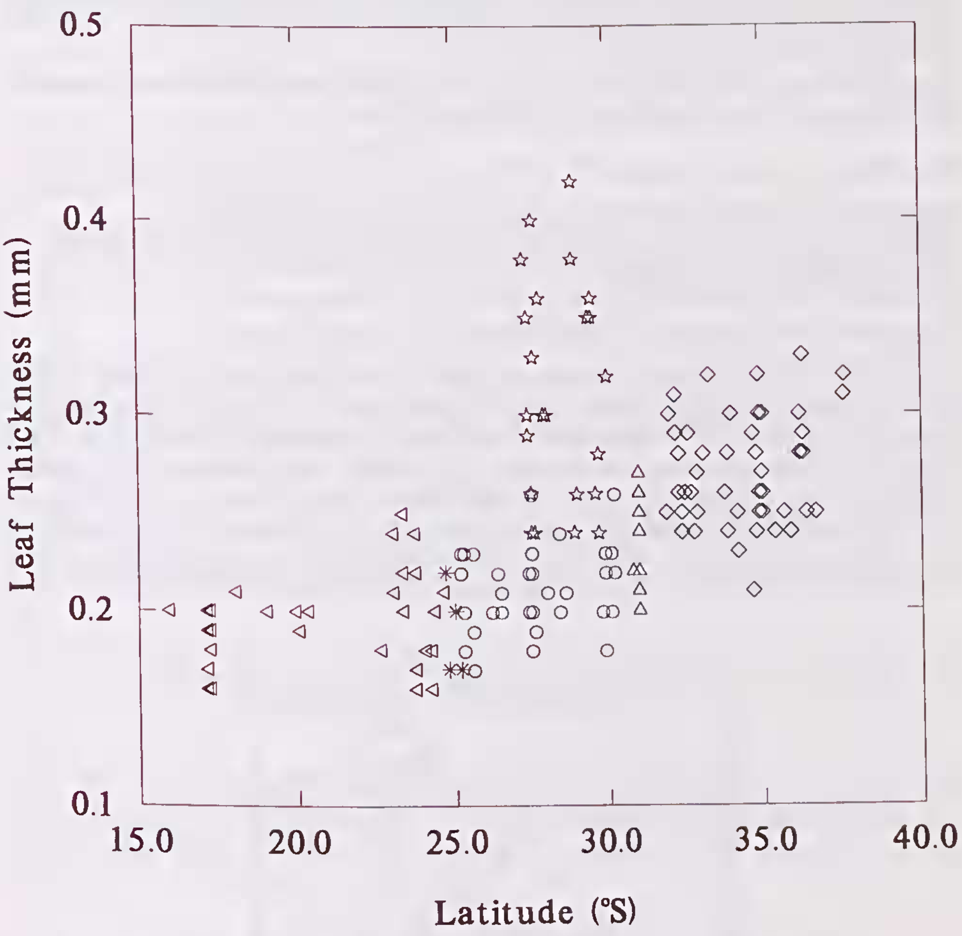

Fig. 91. Variation in section *Politaria* – *C. henryi* (5-pointed star), other symbols as in Fig. 89.

the coast division of New South Wales from the Manning River valley south to near Bega, with an outlying occurrence near Nowa Nowa in eastern Victoria. It occurs also near the main divide at the head of the Goulburn River in New South Wales (Fig. 87).

Intersectional hybrids are known with members of section *Rufaria*, namely *C. gummifera* (this hybrid has been called *Eucalyptus nowraensis* Maiden, see discussion under excluded names) and *C. intermedia* (Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 58 examined): New South Wales: North Coast: Taree, *Swain 18*, Mar 1905 (NSW); Gloucester Buckets, *Constable 5980*, 16 June 1965 (NSW); Mt Wambo, 5 miles [8 km] NW of Bulga, *Constable*, 30 Aug 1957 (NSW 302653); Great Sugarloaf [Mtn], W of Newcastle, *Story 6559*, 6 Aug 1959 (NSW, CANB). Central Coast: Morisset, *Laseron*, Feb 1914 (NSW); 3/4 mile [c. 1 km] S of Prospect Hill, *Cambage 3590*, 15 Sep 1912 (NSW); Theresa Park to Orangeville, *Johnson*, 5 Sep 1951 (NSW 17594). South Coast: 2 miles [3 km] S of Nowra, *Gallagher*, 6 Mar 1923 (NSW); 39.8 km NNE of Batemans Bay on highway, *Chippendale 887 & Beeston*, 26 Feb 1974 (CANB, NSW); Lake Nelson, near Tathra, *Walker ANU 1019*, Feb 1963 (CANB, NSW). Central

Tablelands: Spotted Gum Ridge, Wingello, *McGiltivray 936*, 1 June 1959 (NSW). Central Western Slopes: 10 km S of Cassilis towards Ulan, *Martin*, Aug 1951 (NSW 17150); Ravensworth, *Macqueen*, July 1913 (NSW 302792).

Victoria: 300 metres from Mottle Range Road on Monument Road (NE of Nowa Nowa), *Hill 1382 & Johnson*, 18 Feb 1986 (NSW, CANB, MEL, PERTH).

86. ACSAAX **Corymbia henryi** *(S.T. Blake) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus henryi* S.T. Blake, Austrobaileya 1: 4 (1976).

Type: Queensland: Stafford near Brisbane, *S.T. Blake 19889*, 8 Jan 1956 (holo BRI; iso NSW, CANB ex FRI, CANB, K).

This species had previously been included in *E. maculata* Hook.

Tree to 35 m. *Bark* smooth throughout, white to pale grey, pink or cream, usually even in colour, shedding in small sheets or scales and usually mottled. *Juvenile leaves* disjunct after node 2–3, setose with bristle-glands, elliptical to ovate, peltate and cordate for few to many nodes, to 16 cm long, to 90 mm wide; *petioles* to 20 mm long. *Intermediate leaves* disjunct, non-setose, ovate to broad-lanceolate, acute to obtuse, to 30 cm long, to 150 mm wide; *petioles* to 20 mm long. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, thick (0.23–0.42 mm), amphistomatic and concolorous, glossy or semi-glossy, acuminate, 15–28 cm long, 25–45 mm wide; *petioles* 12–25 mm long;

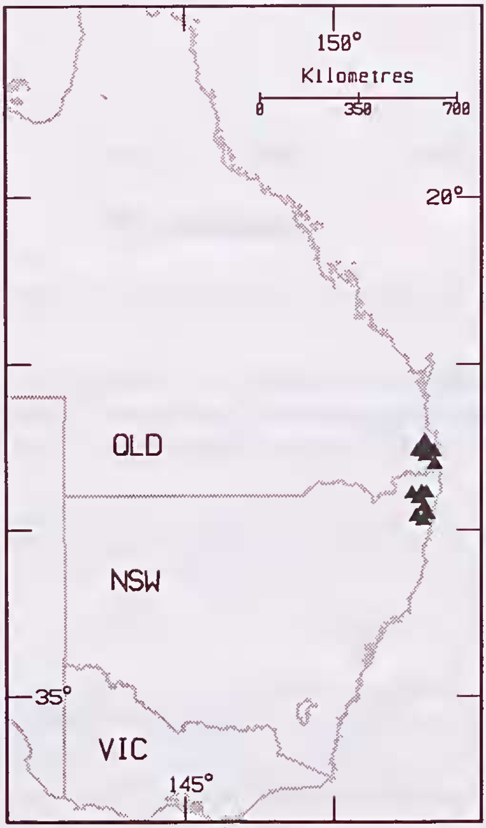

Fig. 92. Distribution of *C. henryi*.

intramarginal vein distinct; *oil glands* abundant, regular. *Umbellasters* 3-flowered; *peduncles* 3–7 mm long; *pedicels* 2–4 mm long. *Mature buds* ovoid; 9–13 mm long, 6–8 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* globoid-urceolate to ovoid-urceolate, 11–20 mm long, 10–16 mm diam.; 3-locular; *disc* c. 3 mm wide. *Seeds* glossy, red-brown, dorsiventrally compressed with a median dorsal keel, 2–3 mm long, 1.5–3 mm wide.

Flowering: Recorded Jan, Apr.

Distinguished within section *Politaria* by the larger and thicker leaves at all stages, the adult leaves with coarse venation more acute than that found in large leaves that occur in some southern examples of C. *maculata*, and by the larger buds, flowers and fruits.

Locally abundant in dry sclerophyll forest on somewhat infertile soils, often but not always on more or less level country, from the latitude of Brisbane in Queensland southward to near Glenreagh, south of Grafton, New South Wales (Fig. 92).

Hybrids or local intergrades may be expected where C. *henryi* comes into contact with C. *variegata*, but collections are lacking. A notable intersectional hybrid is recorded with C. *torelliana* of section *Cadagaria*, in cultivation (Appendix 1).

Conservation status: Locally abundant in two disjunct areas, not considered to be at risk.

Selected specimens (from 31 examined): Queensland: Dinmore, *Arvier*, 12 Nov 1980 (BRI, CANB, NSW); Anzac Park, foot of Mt Coot-tha, *Johnson*, 31 May 1961 (NSW 302291); near Goodna, *Pryor*, July 1936 (NSW 302297); near Nerang, *Blake 20508*, 20 Jan 1959 (BRI, CANB, NSW).

New South Wales: North Coast: near Piora, 10 miles [16 km] W of Casino, *Benham 7*, Apr 1966 (NSW); 15.4 km S of Whiporie towards Grafton, *Chippendale 1288 & Brennan*, 16 Apr 1975 (CANB, NSW); Lower Southgate, *Froggatt*, Apr 1912 (NSW 302310); Ramornie, *Blakely & Shiress*, July 1922 (NSW 302311); crest of Dirty Creek Range, *Hill 4296, Johnson & Noble*, 2 Nov 1992 (NSW).

ACU Section **Blakearia**

Section *Blakearia* (the 'ghost gums' or 'paper-fruited bloodwoods') is a distinctive, primarily tropical group of 27 species (Figs. 17, 93). The names 'Carbeen' and 'Moreton Bay Ash' have also been applied to species in this group. The group reaches maximum diversity in monsoon savannah woodlands of northern Australia from Queensland through the Northern Territory and the Kimberley region of Western Australia, with eight species extending south of the Tropic of Capricorn, three of these essentially eastern, two western and three central but with extension to the east and/or west. Three species also occur in southern parts of the island of New Guinea, one being endemic.

The first species named in the group was *Eucalyptus clavigera*, described by Schauer in 1843 from Allan Cunningham's notes and specimens. The next species to be recognised was illegitimately published as *E. viminalis* by W.J. Hooker from Mitchell's collections (the name being pre-occupied by *E. viminalis* Labill.). Mueller (1859) next described *E. aspera*, *E. polysciada*, *E. confertiflora* and *E. tessellaris*, not perceiving the latter's affinity with Hooker's *E. viminalis*, for which he coined the nomen novum *E. hookeri*. Bentham included *E. hookeri* in *E. tessellaris*, *E. confertiflora* in *E. ferruginea* [actually a species of section *Rufaria*], and *E. polysciada* in *E. clavigera*. He recognised a fourth species, *E. grandifolia*, from Robert Brown's specimens and notes, as well as the supposed variety *E. tessellaris* var. *dallachiana*. Bentham included the four species (with many other unrelated species) in series *Normales* subseries *Inclusae*.

Mueller (1882, 1889) accepted Bentham's broader circumscriptions of the species, also holding (as Bentham did) a concept of *E. ferruginea* that represented mainly *E. confertiflora*. He placed the four species in the large and heterogeneous 'residual' group *Parallelantherae*. He also described a fifth (non-Australian) species, *E. papuana*, in 1875.

The group was first recognised as a coherent unit by Maiden (Crit. Rev. Eucalyptus 4: 184, 1919). He recognised the same five species, suggesting the group name *Angophoroideae*, but not indicating a rank or indeed that he intended to establish such a group formally. He later placed these species in a separate group (op. cit. 6), section *Macrantherae*, subsection *Longiores*, series *Non-Corymbosae*, subseries *Clavigerae* in his anther classification, and subsequently (op. cit. 7: 113, 1924) in his seed series *Scutiformes* (not intended by Maiden as a taxon name, contra Chippendale 1988). Like Bentham and Mueller, he confused *E. confertiflora* and *E. ferruginea*.

Blakely (1934) recognised the same five species, by then with three varieties, placing them (with several unrelated species) in section *Macrantherae* subsection *Longiores* series *Corymbosae* subseries *Tessellatae* and *Setosae*. He included the type of *E. confertiflora* in *E. ferruginea*, but regarded the widespread species later recognised as *E. confertiflora* as part of *E. clavigera*.

Blake (1953) recognised seven species, perceiving the distinctive nature of *E. confertiflora* (and the very different *E. ferruginea*) and raising Maiden and Blakely's *E. clavigera* var. *gilbertensis* to species rank. He placed all species in a separate series *Clavigerae*, but removed *E. ferruginea* to series *Corymbosae*.

Pryor & Johnson (1971) elevated Blake's series to the (extracodical) subgenus *Blakella*, with the same seven named species and two undescribed species. They did not attempt to subdivide the subgenus further. Our extracodical epithet *Blakearia* is a modification of this to fit the '*-aria*' pattern for names of sections. It commemorates Stanley Thatcher Blake (see further under *C. blakei*).

Chippendale (1988) placed the nine species by then recognised in a series *Scutiformes* (invalid since it is merely a citation of Maiden's invalid seed series; see above). These were the seven from Blake, one of the undescribed species from Pryor & Johnson which had by then been named (*E. kombolgiensis* Brooker & Dunlop), and a then recently discriminated species (*E. ferriticola* Brooker & Edgecombe).

Twenty-seven species are here recognised, 15 of them new and a further three reinstated from synonymy and/or raised from infraspecific rank.

Diagnosis

Rhizomes not recorded. Bark smooth, excorticating in thin sheets; often persistent and tessellated on lower trunk, hard, shortly fibrous-flaky, dark grey. Juvenile leaves opposite and sessile for few or many nodes, some cordate but not peltate, usually with bristle-glands and sometimes with unicellular thin-walled blunt-ended trichomes arising from bristle-glands or from undifferentiated epidermis. Adult leaves disjunct or rarely opposite, amphistomatic, non-setose or less often with bristle-glands. Umbellasters 3–7-flowered (sometimes irregular by condensation or by metatopy), the branched or unbranched inflorescences of these borne either in leaf-axils or sometimes also terminally, and sometimes themselves reduced and ± umbellaster- or fascicle-like. Perianth 4-merous; gynoecium with 3 carpels. Calyx calyptriform, ± caducous; corolla calyptriform, not thickened. Stamens all fertile, anthers dorsifixed, versatile, oblong-elliptical, dehiscing by parallel slits. Style straight in bud, tip engaged in a pit in the calyptra. Stigma tapered, lobed, with the papillae relatively few and short. Cotyledons rounded or reniform, not folded in embryo. Seeds dorsiventrally compressed, saucer-shaped, with a narrow circumferential wing; hilum ventral. Fruits ovoid to globular, often truncate or urceolate, thin-textured and ± papery, dehiscing immediately upon maturity; capsule deeply sunken; valves enclosed; columella present.

Bark

Bark is characteristically smooth and pale, varying from white through pale pink, grey or green, sometimes becoming seasonally salmon-coloured or orange (e.g. in *C. gilbertensis*). The smooth bark sheds annually in thin, often large, scales.

In most of the series, some or all species show a characteristic sharply demarcated stocking of hard, shortly fibrous and scaly, dark grey, closely tessellated bark, though in some species of those series (e.g. *C. bella*, *C. torta* in part, *C. blakei*, *C. candida*) this bark is found only at, or almost at, ground level, the trunks being smooth. Tessellation is a feature shared with most other *Corymbia* species, but the hardness and dark grey coloration characterises *Blakearia*. In the series *Grandifoliae* the bark is characteristically entirely smooth, but can show occasional, less thick and regular tessellations in response to injury, for example from fire; such irregularly scaly bark occurs also in series *Clavigerae* (and in the hybridogenous *C. paractia*). All species can show it patchily after fire.

Leaf characters

The first few juvenile leaves of all the species for which they are known are sessile, glabrous, bristle-free and opposite. Bristle-glands are developed before node 5, and simple unicellular epidermal hairs are developed concurrently or not at all. Species such as *C. aspera* retain a near-juvenile form to maturity, whereas others such as *C. disjuncta* retain bristle-glands but have later leaves that become disjunct and petiolate. Bristle-glands bear lateral simple hairs in *C. karelgica*, *C. dendromerinx*, *C. chillagoensis*, *C. gilbertensis*, *C. inobvia*, *C. blakei* subsp. *blakei*, and *C. paractia*. Slight or incipient development of this condition may be evident occasionally in some other species, e.g. *C. confertiflora*. In the series *Confertiflorae*, *Gilbertenses* and *Asperae* all epidermal cells of the abaxial surface are shortly papilliferous; these papillae, consisting of bulges of the epidermal cells, appear to be an apomorphy independent of the more scattered and elongate trichomes here described as simple hairs.

Although cordate leaf-stages are general, fully peltate stages do not occur. This may well be the plesiomorphic condition for *Blakearia*; on the other hand, a fully peltate condition may perhaps have been lost by condensation of stages in the ontogenetic leaf-spectrum, as has clearly occurred in some members of sections *Rufaria* and *Ochraria*.

Regularly pinnate venation at a high angle to the midrib occurs in series *Tessellares* and *Kombolgienses*. To varying degrees, the broader-leaved or more neotenous species of series *Confertiflorae*, *Gilbertenses*, *Asperae* and *Grandifoliae* show retention of the looped, brochidodromous juvenile lateral venation or a modification of this state. Species of *Grandifoliae* show somewhat less regularity of the reticulum, with more widely spaced lateral veins (Fig. 123). Transverse sections and cleared leaves show that oil glands are scattered, large and spherical, though obscured by the epidermis in most species. Although the oil-gland structures are present in many species (and at some stages probably in all), they frequently do not contain appreciable amounts of oil. *C. kombolgiensis* (series *Kombolgienses*) is rather exceptional in having the abundant oil-filled glands clearly evident, except sometimes in old leaves wherein the cuticle has thickened.

Inflorescence morphology

If, for convenience of description, we take the umbellaster rather than the individual flower as the ultimate unit in each inflorescence, the basic inflorescence form is an anthotelic arrangement of 3- or 7-flowered umbellasters (rarely reduced to 1-flowered) borne laterally or terminally along an unbranched (or less often branched) axis (Briggs & Johnson 1979) (Fig. 94). This arrangement is subject to partial or complete reduction or suppression and/or elongation of some or all internodes, as well as having reduced numbers or proliferation of flowers in individual umbellasters (Figs 94, 106, 117, 123).

In series *Papuanae*, which appears to have the most plesiomorphic character-states for section *Blakearia*, inflorescences can be truly terminal on leafy shoots as well as axillary, and sometimes (e.g. in C. *paracolpica*, *Benson 598*) whole leafy shoots can show a range of inflorescence 'flexibility' in this respect, as described for Myrtaceae in general by Briggs & Johnson (1979). This can be seen to a degree also in C. *arafurica*, C. *bella* and C. *papuana*.

In the following descriptions, inflorescences with all internodes evident are termed 'expanded', while those with some suppressed internodes are termed 'condensed'.

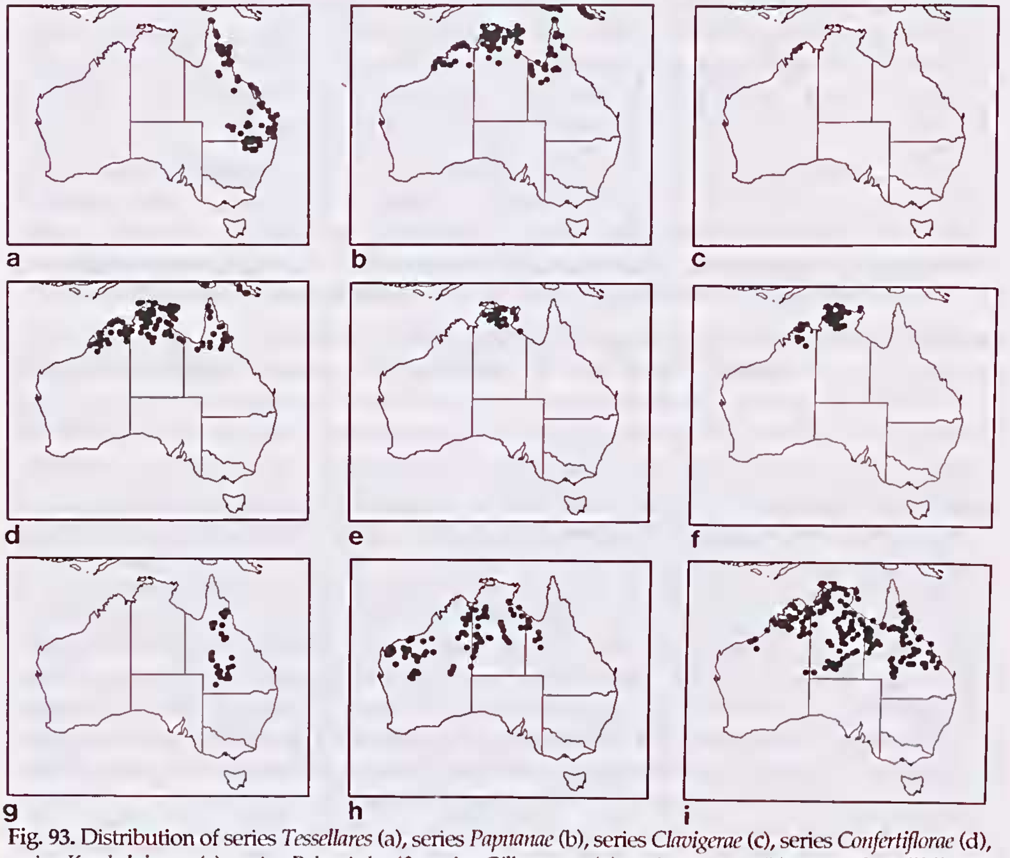

Fig. 93. Distribution of series *Tessellares* (a), series *Papuanae* (b), series *Clavigerae* (c), series *Confertiflorae* (d), series *Kombolgienses* (e), series *Polysciadae* (f), series *Gilbertenses* (g), series *Asperae* (h), series *Grandifoliae* (i).

Where the main axes are themselves branched, the description 'peduncles branched' is used.

Phylogeny

The ghost gums comprise several species-complexes, which show geographic replacement patterns over continuous ranges and sometimes rather extensive intergradation in contact zones between constituent species, suggesting that they are fairly recent radiations and that the group is vigorous and actively evolving. Each clearly coherent complex of this kind is treated here as a separate series; although further (e.g. macromolecular) study may allow grouping of some of them as subseries of more comprehensive series, it is not yet possible to do this with sufficient assurance that such aggregates would be monophyletic (holophyletic).

Nine series are here recognised, as well as one species (*C. paractia*) that shows strong evidence of interserial hybrid origin but forms a consistent and self-sustaining population. One may suspect that *C. clavigera* (series *Clavigerae*), which shows some intermediate conditions in bark and inflorescence, is also ultimately of similar origin, perhaps involving series *Papuanae* and *Grandifoliae*. All the series are primarily tropical in distribution (Fig. 93), though one species, *C. tessellaris*, reaches northern New South Wales, and seven others extend somewhat south of the Tropic of Capricorn (the little-known *C. punkapitiensis* is only known from between 24° and 25°S).

Key to the series

1 Inflorescences expanded, consisting of an elongate rachis bearing opposite, decussate lateral peduncles each of which terminally bears a regularly 3- or 7-flowered umbellaster

2 Pedicels not or little extended (1–8 mm long); inflorescences mostly axillary on leafy branchlets

3 Stocking of finely tessellated bark regularly present; adult leaf venation fine, regular .... series **Tessellares** (ACUA)

3* Stocking mostly not present on trunk or confined to extreme base; adult leaf venation more open and irregular .... series **Papuanae** (ACUC)

2* Pedicels extended (8–17 mm long); inflorescences (at flowering) mostly on leafless portions of branchlets; persistent bark thinly flaky and only irregularly tessellated .... series **Clavigerae** (ACUD)

1* Inflorescences usually with a condensed primary rachis bearing 1-several condensed or expanded lateral peduncles

4 Adult leaves not highly glossy (except sometimes moderately so in *C. torta* (series *Polysciadae*) or *C. candida* (series *Asperae*)); stocking of regularly tessellated bark usually present on trunk (or detectable at ground level)

5 Adult leaves mostly cordate, large, broad-ovate to oblong-ovate and more or less setose, lower surface minutely and closely papillose; peduncles and pedicels expanded .... series **Confertiflorae** (ACUI)

5* Adult leaves *either* not cordate *or* if so then small and inflorescences ± condensed, lower surface of leaves papillose or not

6 Intermediate (except sometimes early in the ontogenetic series) and adult leaves not finely papillose beneath, broad-lanceolate to linear

7 Oil glands clearly evident (in strong transmitted light) in adult leaves .... series **Kombolgienses** (ACUF)

7* Oil glands obscured .... series **Polysciadae** (ACUH)

6* Intermediate and adult leaves closely and finely papillose beneath

8 Bristle-glands of early or adult leaves bearing lateral simple hairs (or bristle-glands very few in *C. blakei* subsp. *rasilis*) .... series **Gilbertenses** (ACUK)

8* Bristle-glands without simple hairs and always present on intermediate foliage .... series Asperae (ACUL)

4* Adult leaves glossy; compact regularly tessellated bark lacking even at base .... series **Grandifoliae** (ACUS)

Note: This key does not accommodate the evidently hybridogenous species *C. paractia* (q.v.), which has characters intermediate between species of series *Confertiflorae* and *Grandifoliae*.

Note to the descriptions: Seeds of ghost gums are difficult to collect because the fruits dehisce immediately on coming to maturity. Consequently, few seedlings have been grown. Moreover, young seedlings are seldom seen or collected in the field. Hence truly juvenile leaves have not been seen for most of the species described hereunder, and the descriptions of early leaf-stages usually begin with intermediate leaves, often derived from coppice shoots.

ACUA Series **Tessellares**

Bark persistent in a distinct, finely tessellated and clearly demarcated stocking on the lower trunk. Juvenile leaves linear to narrow-lanceolate, sparsely setose with bristle-glands. Intermediate leaves bristle-free. Adult leaves dull, finely veined, bristle-free. Inflorescence expanded; umbellasters predominantly 3-flowered (Fig. 94). Branchlets leafy at time of flowering.

A unispecific series occurring in eastern Australia and extending into the Western Province of Papua New Guinea and probably into neighbouring parts of Irian Jaya. It is certainly close to series *Papuanae*, and the two could reasonably be treated as subseries of a single series. This is not done here, pending further elucidation of the interserial relations in *Blakearia* as a whole.

87. ACUAAT **Corymbia tessellaris** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus tessellaris* F. Muell., J. Linn. Soc., Bot. 3: 88 (1859).

Type citation: 'Hab. In graminosis tam collium quam planitierum praesertim arenoso-argillaceorum a parte austro-orientali sinus Carpentaria usque ad sinum Morton [sic] Bay. Anth. Nov., Dec.'

Type: Queensland: Near Laidley, *S.T. Blake 10409*, 26 Jan 1936 (neo NSW, isoneotypes in BRI, CANB, K, MO, PRE). The NSW sheet is here designated as the neotype; see below.

Although typification was not specified in the protologue, a specimen collected from between the Gilbert and Carron Rivers (*F. Mueller*, 1857, MEL, K, BM) has been unjustifiably assumed to be the holotype (Blake 1953, Chippendale 1988). This specimen is apparently the only Mueller collection now extant from the cited range. However, it belongs to a different species (*Corymbia bella* K.D. Hill & L.A.S. Johnson) from the species clearly indicated from the descriptive and general part of the pro-

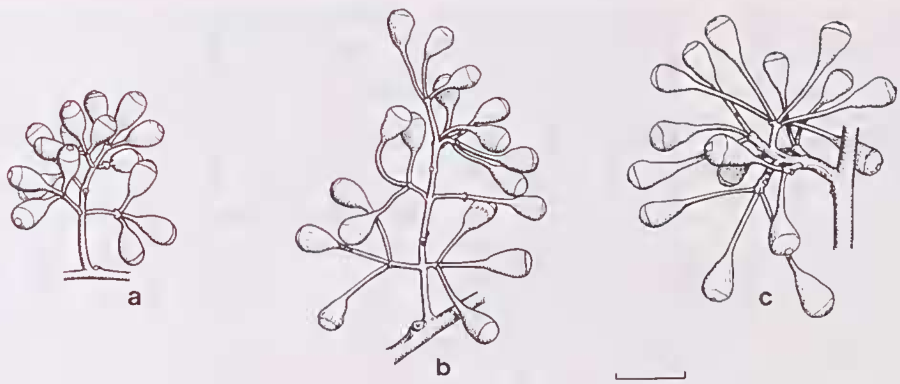

Fig. 94. Inflorescences of a, *C. tessellaris* (from *Clarkson 5674*). b, *C. papuana* (from *Darbyshire 800*). c, *C. clavigera* (from *Kenneally 9000*). Scale bar = 1 cm.

tologue, including in particular the epithet. No material corresponding to these parts of the protologue has been traced in BM, K or MEL by our searches or by Chippendale (1974). These circumstances call for the designation of a neotype to represent the species that was primarily intended by Mueller, and to which the name has customarily been applied. The sheet cited is the primary one examined by us, distributed from a set of *Blake 10409* originally in BRI.

= *E. viminalis* Hook., in Mitchell, Trop. Austral.: 157 (1846), nom. illegit.; non Labill. (1806).

Type citation: Journal entry for 9 May 1846: 'This day we discovered a new Eucalyptus which casts its bark in small angular pieces.'

Type: Queensland: Camp 14 (SE of Roma), *T.L. Mitchell*, 9 May 1846 (holo K; iso NSW; CGE). Referred to *E. tessellaris* by Bentham, 1867.

≡ *E. hookeri* F. Muell., J. Linn. Soc., Bot. 3: 90 (1859); as a nomen novum for *E. viminalis* Hook. (preoccupied by *E. viminalis* Labill.), and mistaking its affinities.

Tree to 30 m, usually with a straight, long bole. *Bark* smooth, white, pale grey or pale grey-green, shedding in thin scales, with a sharply demarcated, hard, tessellated, grey-black stocking over about half the trunk. *Juvenile leaves* opposite, setose for about 4–6 nodes with bristle-glands, linear to lanceolate, to 9 cm long, to 14 mm wide; *petioles* 0–2 mm long. *Intermediate leaves* opposite, bristle-free, linear to lanceolate, acute, to 24 cm long, to 20 mm wide; *petioles* 2–5 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, narrow-lanceolate to lanceolate, acuminate, 12–18 cm long, 7–17 mm wide; *petioles* 5–11 mm long; *oil glands* abundant but obscure. *Inflorescences* expanded, basal internode 3-12 mm long, without or more often with second-order peduncles; *umbellasters* 3-(7-)flowered; *peduncles* 2–4(–6) mm long; *pedicels* 2–4(–6) mm long; 2–4 intermediate internodes each 2–5 mm long; basal internode 4–11 mm long. *Mature buds* pyriform, 5–6 mm long, 3–5 mm diam.; *calyptra* 1/4–1/2 as long as hypanthium, patelliform to hemispherical. *Fruits* ovoid, 8–11 mm long, 6–8 mm diam. Fig. 94.

Flowering: (July–Sep–)Oct–Jan, generally Oct–Nov in the north and more usually Dec–Jan in the south of the range.

Distinguished by the combination: inflorescences wholly expanded (no internodes greatly reduced); adult leaves narrow, dull, finely and regularly veined; persistent bark forming a sharply demarcated stocking on the lower trunk.

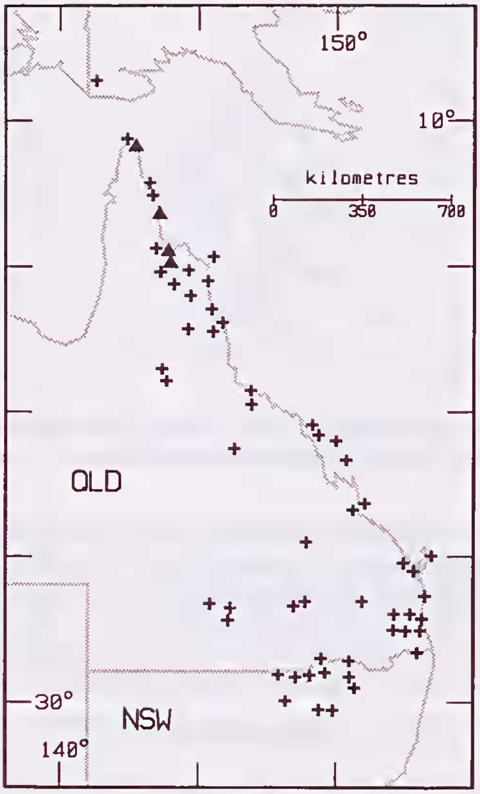

Fig. 95. Distribution of *C. tessellaris* (plus), *C. paracolpica* x *C. tessellaris* (triangle).

C. tessellaris ranges from Cape York through eastern Queensland south to north of Kyogle and Narrabri in northern New South Wales, extends into the Western Province of Papua New Guinea and is to be expected in south-eastern Irian Jaya (Fig. 95). The species extends into more inland country in the south of the range, and its distribution runs into northern New South Wales on both the eastern and western sides of the Great Dividing Range. It is absent from the intervening, colder tablelands country. We have also definitely observed (but not collected) this species in central northern Queensland, on 'Robinhood' Station south-east of Forsayth; no herbarium specimens representing this occurrence have been seen.

Locally abundant in grassy woodlands, usually on medium to lighter soils on flat sites, often on floodplains or along creek-lines.

Maritime forms from coastal headlands and continental islands off the Queensland coast display relatively shorter and broader adult leaves, and often a low or prostrate habit associated with wind-shear. Trees from near-coastal sites in northern Cape York Peninsula (Fig. 95) often display relatively broader adult and juvenile leaves and a denser, less pendulous and less graceful crown; this is thought to be the result of local interbreeding with *C. paracolpica* (q.v. and Appendix 1).

A hybrid is known with *C. torelliana* of section *Cadagaria* (see Appendix 1). This is one of only two known cases of hybridism between *Blakearia* and another section. A hybrid is also known with *C. confertiflora* of series *Confertiflorae* (see Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 83 examined): Queensland: c. 0.5 km W of airport, Horn Island, *Johnson 7793*, 18 Aug 1974 (NSW); 500 metres W of Bolt Head, *Hill 1814, Hind & Healey*, 26 July 1986 (NSW, BRI, CANB, DNA, K, MEL, PERTH); Palfrey Island, near Lizard Island, *Batianoff 10301*, 5 Oct 1988 (BRI, NSW); river crossing 63.8 km [102 km] from Laura towards Coen, *Brooker 4057*, 13 Aug 1973 (CANB, NSW); 1.5 km N of Big Mitchell Creek on Mareeba to Mt Molloy road, *Clarkson 6588*, 5 Oct 1986 (BRI, CANB, NSW, QRS, PERTH); Chillagoe, *Doran*, 9 Oct 1911 (NSW); Reid River, near Townsville, *Daley*, Jan 1912 (NSW 21461); Lindeman Island, near airstrip, *B. Briggs 2111*, 11 Aug 1968 (NSW); 'Mirtna' station, S of Charters Towers, *Clark*, Jan 1915 (NSW); Middle Percy Island, *Batianoff 11638, Champion, Thompson & Dillewaard*, 1 Nov 1989 (BRI, NSW); behind Putney Beach, Great Keppel Island, *Batianoff 9776 & Dillewaard*, 17 Nov 1988 (BRI, CANB, NSW, PRE); 37.8 km ESE of Rolleston towards 'Bauhinia Downs', *Chippendale 1098 & Brennan*, 15 Sep 1974 (CANB, NSW); 1.1 km NW of Middle Rocks, Fraser Island, *Weston 1518 & Richards*, 9 Jan 1990 (NSW); 55 km N of Wyandra road on Cunnamulla-Charleville road, *Blaxell 89/003, Johnson & D'Aubert*, 22 July 1989 (NSW); between Sandgate and Bald Hills, *Blake 18452*, 5 June 1949 (BRI, NSW); 69 km from Mungindi to Tallwood, *Turner & Johnston 423*, 5 Mar 1981 (CANB, NSW).

New South Wales: North Coast: Findon Creek–October Creek junction, *Floyd 509*, 20 July 1977 (NSW). North Western Plains: Mt Mitchell, Warialda district, *de Beuzeville 12*, 10 Nov 1912 (NSW); near McIntyre River, Boggabilla, *Johnson & Constable*, 10 Nov 1954 (NSW 32215); 2 km S of Angledool township, *Milthorpe 3836 & Cunningham*, 23 Sep 1975 (NSW); Barwon River, 5 miles [8 km] from Walgett, *Wynne*, 1 Aug 1954 (NSW 302679); c. 10 miles [16 km] from Narrabri, *Blakely*, Aug 1936 (NSW 21466).

Papua New Guinea: 13.3 km E of Weam on Morehead Road, *Pryor*, 1 Aug 1979 (CANB, NSW 302981).

ACUC Series **Papuanae**

Stocking of tessellated bark irregularly developed or absent. Juvenile leaves (seen only in *C. papuana*) ± setose with bristle-glands, broad-lanceolate or broader. Intermediate leaves bristle-free. Adult leaves dull, more coarsely and irregularly veined than in series *Tessellares*, bristle-free. Inflorescences expanded, regularly branched, mostly axillary but occasionally some truly terminal on leafy shoots (especially in *C. papuana* and *C. paracolpica*); umbellasters 3(-7)-flowered (Fig. 94). Branchlets leafy at time of flowering.

The probably plesiomorphic feature of 'flexible' development in the inflorescence-bearing shoots found in this series is mentioned above, under section *Blakearia*.

A widespread series of four species, occurring in a geographic replacement pattern across the monsoon tropics of Australia, with one species endemic in Papua New Guinea. Zonal intergradation occurs rather extensively among species within the series, as well as limited hybridisation or local intergradation with some species from other series. The whole series is here regarded as constituting the Superspecies *Papuana* (Appendix 3). It could perhaps reasonably be treated as a subseries of series *Tessellares*.

88. ACUCCE **Corymbia papuana** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus papuana* F. Muell., Descr. Notes Papuan Pl. 1(1): 8 (1875).

Type citation: 'On the mainland of New Guinea opposite to Yule-Island, about twelve miles distant from the shores.' 'The collection transmitted by Sir Will. Macarthur...'

Type: New Guinea, *P.R. Reedy 139* (holo MEL; iso NSW). Collected in 1875 on the 'Chevert' expedition under W. Macleay. Only leaves have been preserved (*fide* Maiden, Crit. Rev. Eucalyptus, 4: 200, 1919; see also Maiden (1915)). The leaf of the isotype matches in all respects leaves of specimens cited below.

Tree to 15 m. *Bark* variably persistent and tessellated on lower trunk; smooth above, white, shedding in thin scales. *Juvenile leaves* opposite, sparsely setose with bristle-

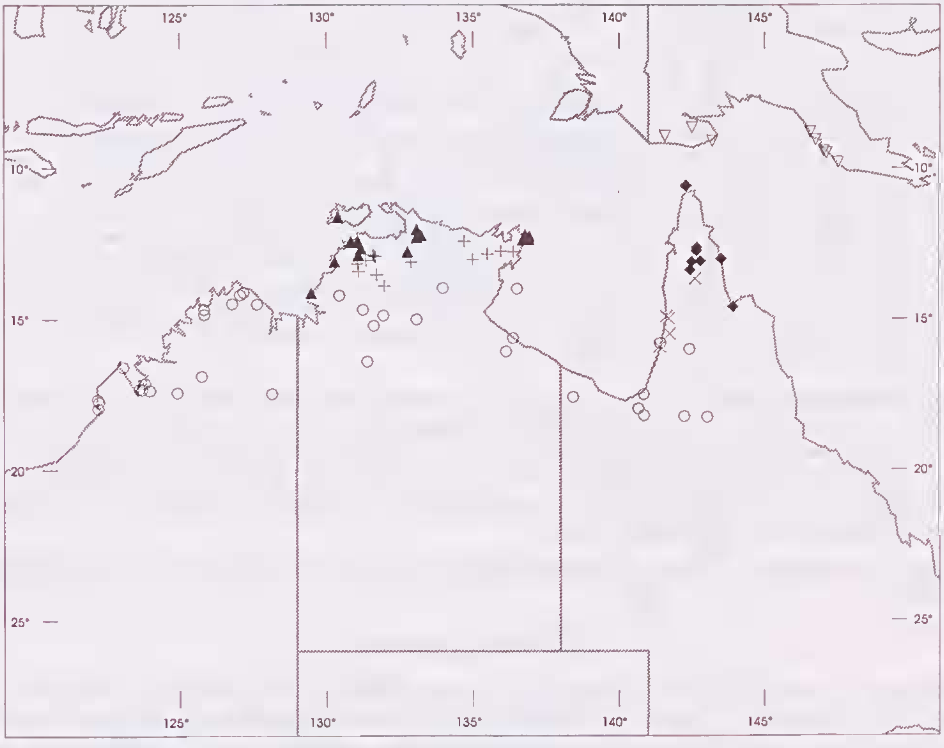

Fig. 96. Distribution of *C. papuana* (open triangle), *C. paracolpica* (diamond), *C. bella* (open circle), *C. arafurica* (solid triangle), *C. bella* – *C. paracolpica* (cross), *C. arafurica* – *C. bella* (plus).

glands (at least on midrib and petiole) ovate to orbicular, cordate, to 12 cm long, to 60 mm wide; *petioles* 3–5 mm long. *Intermediate leaves* opposite, bristle-free, broad-lanceolate, acuminate, to 30 cm long, 80 mm wide; *petioles* 10–13 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, lanceolate to broad-lanceolate, acute or acuminate, 5–12 cm long, 10–24 mm wide; *petioles* 3–13 mm long; *oil glands* abundant but obscured. *Inflorescences* expanded, without or less often with second-order branching, basal internode 5-15 mm long; *umbellasters* 3(-7)-flowered; *peduncles* 9–15 mm long; *pedicels* 4–8 mm long; 2–5 intermediate internodes each 3–10 mm long; basal internode 9–18 mm long. *Mature buds* pyriform to clavate; 4–6 mm long, 3–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, patelliform to shallowly hemispherical. *Fruits* ovoid, 9–11 mm long, 8–9 mm diam. Fig. 94.

Flowering: June–Aug in the Port Moresby district, Oct in the Western Province.

Distinguished by the combination: inflorescences expanded, internodes, peduncles and pedicels long; intermediate leaves very large, often persistent in adult canopy, cordate in early stages; adult leaves dull, petioles relatively short; bark wholly smooth or patchily adherent on the lower trunk. Intermediate leaves may persist to flowering, and the quite small fully adult leaves may not necessarily develop on all mature trees. Both intermediate and adult leaves have generally shorter petioles than present in related species from Australia.

Endemic in southern parts of the island of New Guinea, with most records from Papua New Guinea (Fig. 96). An apparent disjunction exists between the populations around Port Moresby (Central District) and those in the Western Province and south-eastern Irian Jaya. This species is sporadic in distribution, occurring patchily in grassy savannah woodland country, mostly on flats but sometimes on stony soils on hillsides.

Hybrids with C. *disjuncta* are frequent, and have been observed by one of us (LJ) around Port Moresby and east of there (Appendix 1).

The name *Eucalyptus papuana* has been very widely and uncritically applied in Australia to almost any more or less narrow-leaved, smooth-barked species in any series of *Blakearia*, especially to other species of series *Papuanae* and to C. *dallachiana* and C. *aparrerinja* of series *Grandifoliae*.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 21 examined): Papua New Guinea: near Tonda village, S of Morehead, *Henty & Foreman NGF 49429*, 15 Nov 1972 (LAE, NSW); Daru Island, *Hart 5029*, 12 Mar 1953 (LAE, NSW); Kupiano (10°05'S 148°10'E), *Wiakabu*, 6 June 1977 (LAE 70467, NSW); Port Moresby, *White 60, 126*, July–Aug 1918 (BRI, NSW); c. 2.5 miles [4 km] N of Hisiu village, *Darbyshire 800*, 13 Aug 1962 (CANB, NSW); c. 1 mile [1.6 km] SE of Kapa Kapa, Central District, *Schodde 2778*, 14 Aug 1962 (CANB, NSW); Tavai Creek area, c. 43 miles [69 km] SE of Port Moresby, *Pullen 6902*, 4 May 1967 (CANB, NSW).

Irian Jaya: Merauke, *Versteegh BW53*, 26 Oct 1953 (CANB ex L).

89. ACUCCF **Corymbia paracolpica** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Papuanarum* combinatione characterum sequentium distinguitur: cortex laevis vel irregulariter adhaerens versus basin trunci; folia intermedia non maxima; folia adulta haud nitentia, angusta petiolis mediocribus longisve; inflorescentiae expansae internodio basali saepe valde elongato, petiolis mediocribus longisve.

Type: Queensland: 'Batavia Downs', 1 km S of the Embley Range road along Spring Creek Paddock, *V.J. Neldner 2787 & J.R. Clarkson*, 24 Oct 1989 (holo NSW; iso BRI, MBA, QRS).

Tree to 15 m (or sometimes more). *Bark* smooth, white, shedding in thin scales, sometimes with some persistent tessellated bark on lower trunk. *Intermediate leaves* opposite, bristle-free, broad-lanceolate to ovate, acute, to 17 cm long, to 70 mm wide; *petioles* to 6 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, lanceolate to broad-lanceolate, acuminate, 8–22 cm long, 9–30 mm wide; *petioles* 8–16 mm long; *oil glands* abundant but obscure. *Inflorescences* expanded; *umbellasters* 3-7-flowered; *peduncles* 4–11 mm long; *pedicels* 2–8 mm long; 2–5 intermediate internodes each 3–8 mm long; basal internode 6–35 mm long. *Mature buds* pyriform to clavate; 5–6 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, patelliform to shallowly hemispherical. *Fruits* ovoid, 8–10 mm long, 7–8 mm diam. Fig. 97.

Flowering: Oct.

Distinguished by the combination: bark wholly smooth or patchily adherent on the lower trunk; intermediate leaves not very large; adult leaves dull, narrow, petioles of medium length to long; inflorescences expanded, basal internode often greatly elongated, peduncles of medium length to long.

C. *paracolpica* is closest to C. *papuana* (but see also C. *arafurica*) differing in the generally smaller intermediate leaves, the longer and relatively narrower adult leaves, the shorter pedicels and peduncles, and the larger anthers (0.9–1.1 mm long, compared to 0.7–0.9 mm in

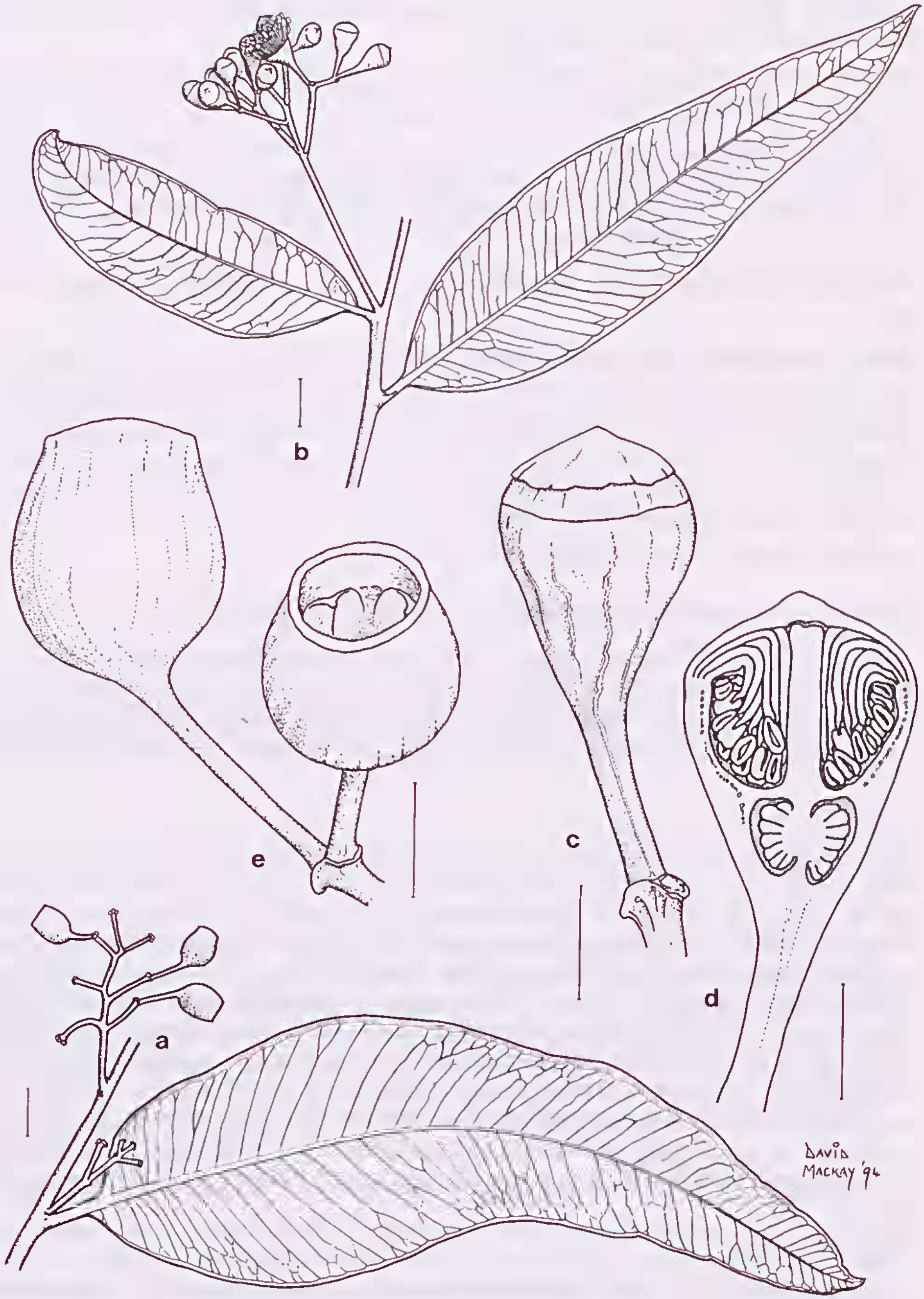

Fig. 97. *C. paracolpica*. a, intermediate leaf, inflorescence and fruits; b adult leaf, inflorescence and buds; c bud; d transverse section of bud; e fruits (a from *Jackes NSW 311143*, b, c, d, from *GCJP A0540*). Scale bars = 1 cm.

C. papuana). *C. papuana* also does not develop the sometimes greatly elongated basal internode in the inflorescences. Material of *C. papuana* from the Western District of Papua New Guinea (including offshore islands) shows some morphological approach to *C. paracolpica*, suggesting that some intergradation may have occurred before the formation of Torres Strait in the south. There appears to be a gradual reduction in both pedicel length and persistent bark in the south of western Cape York Peninsula, indicating intergradation with *C. bella* in the region south from King Edward River and Kowanyama. Hybrids also occur (sometimes extensively, in swarms or locally intergrading populations) with *C. tessellaris* in the contact area of that species with *C. paracolpica* (Fig. 95 and Appendix 1).

Distributed in Queensland, chiefly in Cape York Peninsula, north from Princess Charlotte Bay, extending sporadically around the Gulf of Carpentaria almost to the border of the Northern Territory, into which it probably extends somewhat. Mainly in coastal or subcoastal sites, but also on alluvial soils away from the coast in areas north from about 13°30'S (Fig. 96).

A component of littoral woodland or low open grassy woodland, locally often dominant but very patchy in distribution.

The epithet is from the Greek *para*, beside, and *kolpos*, a bay or gulf, in reference to the occurrence of the species in Cape York Peninsula on the eastern side of the Gulf of Carpentaria, and also on the south of the gulf.

Conservation status: Not considered to be at risk.

Selected specimens (from 12 examined): Queensland: Horn Island, King Point, *GCJP A0540*, 30 Aug 1989 (NSW); Kings Beach, Horn Island, *Jackes*, 7 July 1986 (NSW 311143); 18.4 km S of Wenlock River on Peninsula Development road, *Clarkson 5695*, 7 Nov 1984 (BRI, CANB, K, NSW, QRS); 47 km N of Archer River on Peninsula Development Road, *Hill 1773, Hind & Healey*, 22 July 1986 (NSW); 7 km SE of Merluna (13°06'S 142°30'E), *Benson 598*, 8 Oct 1973 (NSW); 20 miles [32 km] from Weipa, *Sweeney*, 17 Sep 1959 (BRI); Mornington Island, between headwaters of Gulgerg Creek and headwaters of Elizabeth River, *Fosberg 62059*, 18 Sep 1981 (BRI); Wentworth Station, on road to beach from Wollogorang Station [16°58'S 138°04'E], *Halford 841210*, 2 Dec 1984 (BRI).

90. ACUCCJ **Corymbia arafurica** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Papuanarum* combinatione characterum sequentium distinguitur: inflorescentiae expansae; folia intermedia magna lataque; folia adulta lata petiolis longis; cortex saepissime irregulariter persistens in parte basali trunci.

Type: Northern Territory: Oenpelli, *R.L. Specht 1085*, 29 Sep 1948 (holo NSW; iso CANB).

Tree to 15 m (or sometimes more). *Bark* smooth, white, shedding in thin scales, sometimes irregularly persistent on the lower trunk. *Intermediate leaves* opposite, bristle-free, broad-lanceolate to broad-ovate, obtuse to acute, to 17 cm long, 90 mm wide; *petioles* 5–13 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, narrow-lanceolate to lanceolate, acuminate, 9–20 cm long, 20–45 mm wide; *petioles* 5–26 mm long; *oil glands* abundant but obscure. *Inflorescences* expanded; *umbellasters* 3-flowered; *peduncles* 2–6 mm long; *pedicels* 4–8 mm long; 2–5 intermediate internodes each 2–7 mm long; basal internode 6–20 mm long. *Mature buds* pyriform to clavate; 5–6 mm long, 4–5 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 9–12 mm long, 7–9 mm diam. (Fig. 98).

Flowering: Sep–Oct.

Distinguished by the combination: inflorescences expanded; intermediate leaves large, broad; adult leaves dull, broad, petioles long; bark usually patchily persistent on

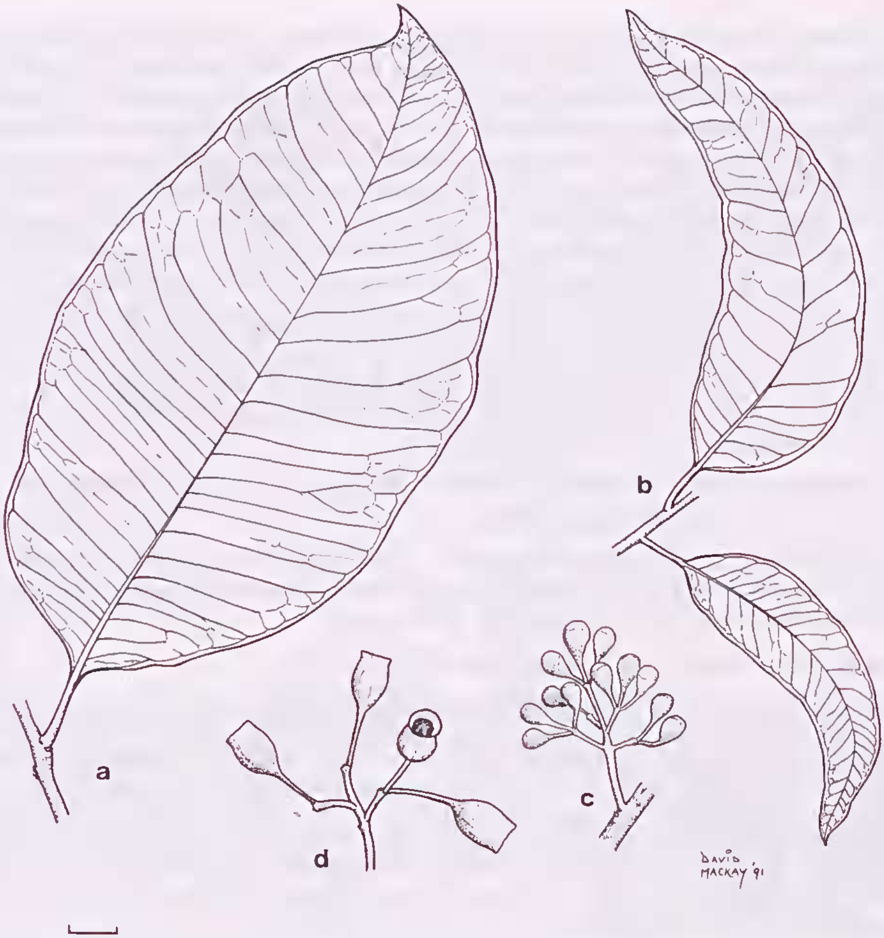

Fig. 98. C. *arafurica*. a, intermediate leaf. b, adult leaf. c, inflorescence and buds. d, inflorescence and fruits (a, d from *NSW 10148*, b, c from *Specht 1085*). Scale bar = 1 cm.

lower trunk. Pedicels are generally longer than those of the related *C. bella* (which has consistently narrower adult and intermediate leaves), and all inflorescence internodes are generally shorter than those of the closely related and ecologically corresponding *C. paracolpica*. Anthers are smaller (0.7–0.9 mm long, compared to 0.9–1.1 mm in *C. paracolpica*). Flowering also occurs earlier than in *C. bella*, probably associated with the earlier onset of effective rains in the more northerly region inhabited by *C. arafurica*.

Locally abundant across the northern parts of the Northern Territory, generally north of 13°S, and mostly in near-coastal situations (Fig. 96).

Usually on relatively deep and fertile soils along or near watercourses, as well as on headlands or on beach-dune systems. Often locally abundant or dominant, but very patchy in distribution. Extensive intergradation occurs with *C. bella* through a somewhat inland zone lying to the south of the distribution of *C. arafurica* (Fig. 96). Hybrids are recorded with *C. disjuncta* and *C. pauciseta* (see Appendix 1).

The epithet refers to the occurrence of the species in a region bordering the Arafura Sea.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 12 examined): Northern Territory: 5.8 km from Murgenella road on Maningrida road, *Hill 3981 & Stanberg*, 31 Aug 1991 (NSW, CANB, DNA); first creek N of Cooper Creek on Murgenella road, *Brooker 5360*, 3 Oct 1976 (CANB, NSW); 12.7 km from Gove road on Dalywoi Bay road, *Hill 3954 & Stanberg*, 27 Aug 1991 (NSW, CANB, DNA); Howard Creek, near Darwin, *G.F. Hill 363*, 26 Nov 1915 (NSW 10148); at seafront, Fannie Bay, *Brooker 3198, 3199*, 28 June 1971 (CANB, NSW); Giddy River crossing, *Hill 3957 & Stanberg*, 27 Aug 1991 (NSW, CANB, DNA); 29.3 km from Labelle Downs homestead on track to Channel Point, *Hill 4033 & Stanberg*, 8 Sep 1991 (NSW, CANB, DNA BRI).

91. ACUCCL **Corymbia bella** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Papnanarum* combinatione characterum sequentium distinguitur: folia intermedia parva angustaque; folia adulta angusta; inflorescentiae expansae pedunculis pedicellis brevibus; cortex totus laevis.

Type: Northern Territory: 64.5 km N of Larrimah, *K. Hill 3278, L. Johnson & L. Stanberg*, 9 Nov 1988 (holo NSW; iso DNA).

Tree to 30 m. *Bark* smooth, white, shedding in thin scales, rarely with a small amount of adherent bark near the base. *Intermediate leaves* opposite, bristle-free, lanceolate to broad-lanceolate, acute, to 11 cm long, 25 mm wide; *petioles* 2–5 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, linear to lanceolate, acuminate, 7–22 cm long, 6–25 mm wide; *petioles* 5–21 mm long; *oil glands* largely obscured, small. *Inflorescences* expanded; *umbellasters* 3-flowered; *peduncles* 2–4 mm long; *pedicels* 1–5 mm long; 2–5 intermediate internodes each 2–7 mm long; basal internode 5–10 mm long. *Mature buds* pyriform to clavate; 5–6 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, patelliform to shallowly hemispherical. *Fruits* ovoid, 8–11 mm long, 6–9 mm diam. Fig. 99.

Flowering: Nov–Jan.

Distinguished by the combination: intermediate leaves small, narrow; adult leaves narrow; bark wholly smooth; inflorescences expanded; peduncles and pedicels short. The anthers are of medium size for the series (0.8–1.0 mm long).

Widespread and locally abundant across northern Australia, from Broome and Cape Leveque in Western Australia to east of Croydon in Queensland, mainly in moderately wet regions but extending inland to around Halls Creek, Katherine, and east of Cloncurry (Fig. 96). Replaced by related species in the higher-rainfall coastal regions of the Northern Territory and Queensland.

Usually on alluvial soils in locally wetter areas along watercourses, sometimes forming extensive gallery forests, for example along parts of the floodplain of the Macarthur River in the Northern Territory.

C. bella intergrades with *C. arafurica* and *C. paracolpica* in contact zones (Fig. 96), and hybrids occur with *C. confertiflora*, *C. disjuncta* and *C. grandifolia* (see Appendix 1).

The epithet is from the Latin *bellus*, pretty or attractive, referring to the agreeable appearance of this species with its white trunks and soft green leafy crowns.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 36 examined): Western Australia: near racecourse, Broome, *Brooker 10108*, 17 Oct 1988 (CANB, NSW); Cygnet Bay, *Fitzgerald*, Nov 1906 (NSW21448); Derby, *Gardner 1629*, 16 Oct 1921 (PERTH, NSW); Windjana Gorge, *Hill 3441, Johnson & Stanberg*, 23 Nov 1988 (NSW, CANB, PERTH); track to Adcock Gorge, *Hill 3395, Johnson & Stanberg*, 20 Nov 1988 (NSW); 2 km W of Berkeley River (14°30'S 127°38'E), *Brooker 7772*, 2 Nov 1982 (CANB, NSW); 68 miles [109 km] from Halls Creek towards Turkey Creek, *Gittins 1403*, July 1967 (NSW).

Northern Territory: Little Lagoon, Groote Eylandt, *Specht 443*, 30 May 1948 (CANB, NSW); edge of plain near Emu Point, 14°12'S 130°26'E, *Hill 4049 & Stanberg*, 10 Sep 1991 (NSW, CANB, DNA BRI PERTH); 20 miles [32 km] SW of 'Dorisvale' station, *Perry 2779*, 18 May 1952 (CANB, NSW); 16.6 km from Mainoru road on Gove road, *Hill 3908 & Stanberg*, 24 Aug 1991 (NSW, CANB, DNA); 12.4 km NE of Willeroo Junction, *Hill 3344, Johnson & Stanberg*, 17 Nov 1988 (NSW); 3 km E of 'Bing Bong' homestead, *Latz 10245*, 3 Sep 1985 (DNA, NSW).

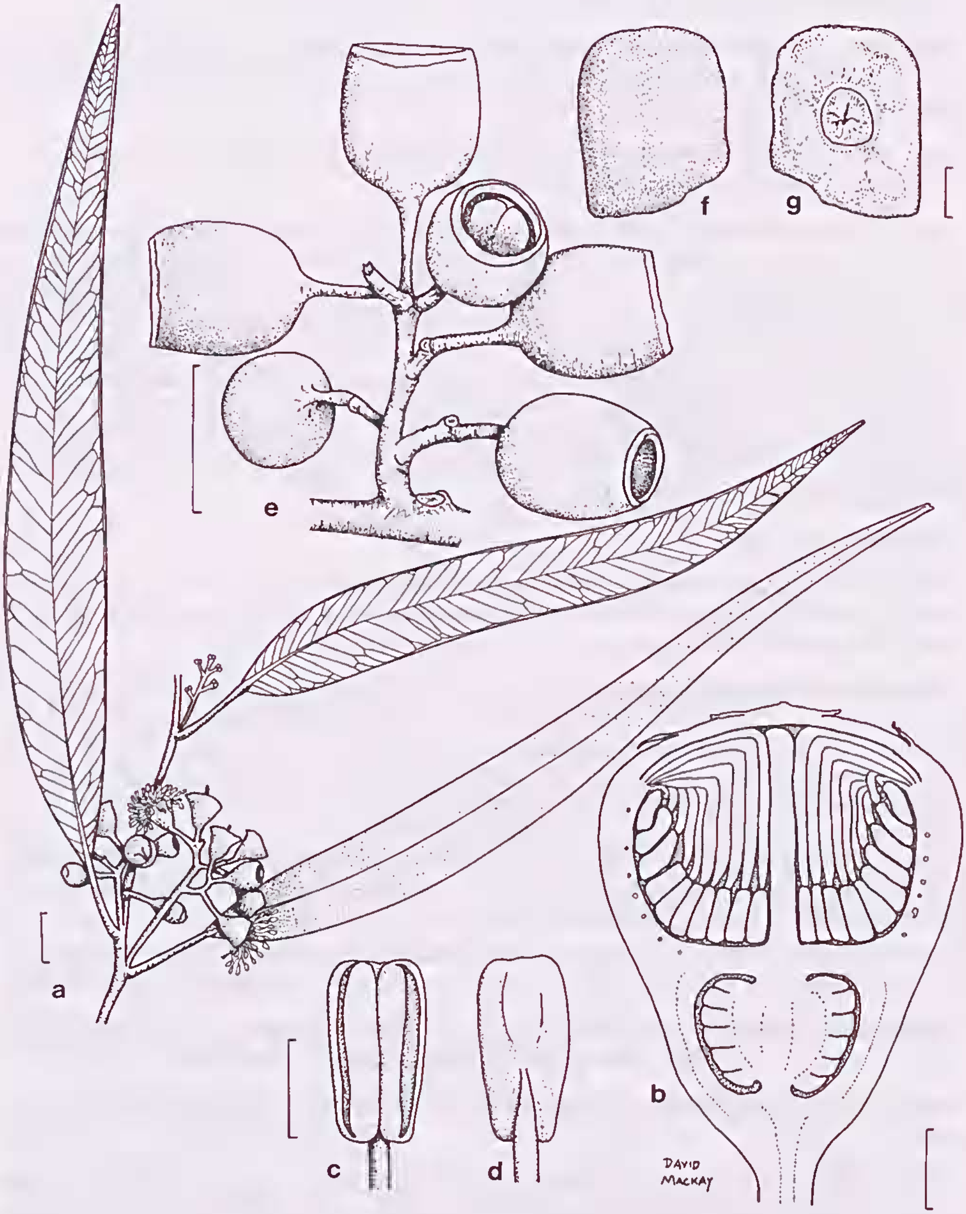

Fig. 99. *C. bella*. a, adult leaves, inflorescence, buds and flowers. b, transverse section of bud. c, d, anther. e, inflorescence and fruits. f, g, seed (all from *Puttock & King UNSW 17121*). Scale bar; a, e = 1 cm; c, d = 0.5 mm; b, f, g = 1 mm.

Queensland: Mitchell River crossing, 'Dunbar' station to 'Koolatah' station, *Jackes*, 2 Oct 1985 (NSW 301516); Karumba, *Puttock & King*, July 1984 (UNSW 17121, NSW); 31 km from Westmoreland on Doomadgee track, *Benson 884*, 23 June 1974 (NSW); Little River, 32 miles [51 km] E of Croydon, *Johnson & Pryor*, 20 Oct 1964 (NSW 301520); banks of Corella River, 15 miles [24 km] N of Cloncurry, *McReaddie 12*, 4 Nov 1972 (CANB).

ACUD Series Clavigerae

Inflorescence condensed, anthotelic; umbellasters 3–7-flowered (Fig. 94). Branchlets leafy or more often leafless (in flowering region) at time of flowering. Juvenile leaves not seen. Intermediate leaves bristle-free, broad-lanceolate to lanceolate. Adult leaves dull, with rather irregular venation. Bark persistent in an indistinctly demarcated and rather irregularly scaly stocking on the lower trunk. Pedicels extended.

A unispecific series in north-western Australia, not unlikely to be of ultimate hybrid origin (see below).

92. ACUDDL **Corymbia clavigera** *(Cunn. ex Schauer) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus clavigera* Cunn. ex Schauer, in Walp., Rep. Bot. Syst. 2: 926 (1843).

Type citation: 'A. Cunn. Herb. no. 242/1820.'

Type: Western Australia: Careening Bay, *A. Cunningham 242*, Oct 1820 (holo K; iso BM, BRI, CANB, NSW). Figured by Maiden (Crit. Rev. Eucalyptus 7: pl. 269, fig. 5, 1926), and by Blake (1953: pl. 10).

Tree to 15 m. *Bark* smooth, white, shedding in thin scales, with a patchy and irregular stocking of persistent bark on the lower trunk. *Intermediate leaves* opposite, setose with bristle-glands, ovate, rounded or apiculate, to 8 cm long, to 50 mm wide; *petioles* to 12 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, lanceolate to broad-lanceolate, acuminate, 7–16 cm long, 14–25 mm wide; *petioles* 12–22 mm long; *oil glands* abundant but obscure. *Inflorescences* condensed; *umbellasters* 3–7-flowered; *peduncles* 2–14 mm long; *pedicels* 8–17 mm long; intermediate internode single, 0–3 mm long; basal internode 4–6 mm long. *Mature buds* pyriform, 7–8 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, patelliform to shallowly hemispherical. *Fruits* ovoid, 11–14 mm long, 7–8 mm diam. Fig. 94.

Flowering: Oct.

Distinguished by the combination: bark patchily persistent but not in a clearly defined stocking; pedicels short to medium-length (to 14 mm); inflorescence internodes not extremely reduced; buds medium-sized; fruits medium-sized. [The epithet *clavigera* (Latin, nail-bearing) applies to the bud-with-pedicel, not to the buds alone.]

The abundant Northern Territory species formerly incorrectly known as *E. clavigera* (e.g. by Blake 1953), and here recognised as *C. polysciada*, has very long pedicels (to 32 mm long) and a very distinct, regularly tessellated stocking. *C. clavigera* is restricted to near-coastal localities in the northern Kimberley region of Western Australia, apparently isolated and uncommon (Fig. 100). We have not seen *C. clavigera* in the field. The sketchy ecological data available indicate that this species occurs on basalt-derived soils, whereas related species in the Kimberley region are mostly confined to sandstone or floodplains. Unlike those of series *Papuanae*, seasonal growth units of *C. clavigera* are largely leafless in the inflorescence-bearing region when flowering.

The likelihood of a hybridogenous interserial origin for *C. clavigera* is mentioned above in the discussion of phylogeny in *Blakearia*; if this was the origin, the species is apparently well stabilised now.

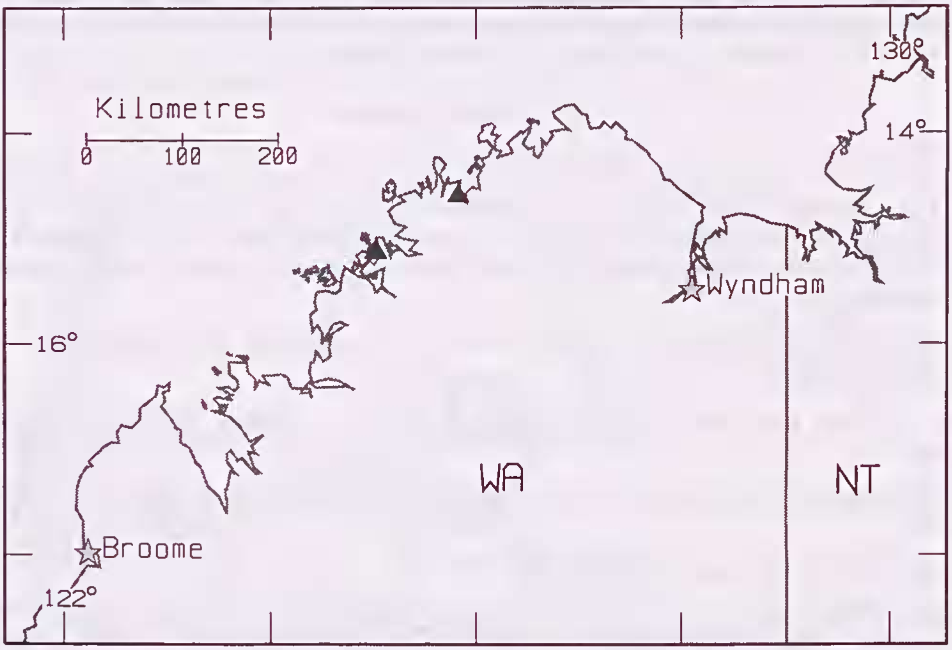

Fig. 100. Distribution of *C. clavigera.*

Conservation status: Poorly collected and from areas very remote from settlement, possibly rare. 2K.

Specimens examined: Western Australia: Careening Bay, *Kenneally 9000*, 11 June 1984 (PERTH, NSW); Warrender road, Mitchell Plateau, *Done 263*, 12 June 1980 (DNA); Crystal Creek road, *Done 79*, 22 Sep 1979 (DNA).

ACUF Series **Kombolgienses**

Distinguished from series *Polysciadae*, *Confertiflorae* and *Gilbertenses* by the clearly evident oil glands in adult leaves, which are narrow-lanceolate, and do not bear bristle-glands or possess a papilliferous surface. There is a stocking of tessellated bark, though this is sometimes confined to the base of the trunk.

A unispecific series; its only member occurs on siliceous rocky outcrops in the north of the Northern Territory. It may constitute a clade with series *Polysciadae*, and would in that case be better treated as a subseries.

93. ACUFFK **Corymbia kombolgiensis** *(Brooker & Dunlop) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus kombolgiensis* Brooker & Dunlop, Austral. Forest Research 8: 212, fig. 7 (1978).

Type: Northern Territory: Mt. Brockman, Koongarra Jump-up, *C.R. Dunlop 4625*, 6 Dec. 1977 (holo CANB ex FRI; iso BRI, CANB, DNA ex NT, DNA, NSW, K).

Tree to 15 m. *Bark* smooth, white to pinkish-grey, shedding in thin scales, often with an irregular grey tessellated stocking on the lower trunk. *Intermediate leaves* opposite, setose with bristle-glands, broad-lanceolate to ovate, obtuse to rounded, to 10 cm long, 50 mm wide; *petioles* 1–10 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, narrow-lanceolate to lanceolate, acuminate, 8–21 cm long, 7–23 mm wide; *petioles* 5–16 mm long; *oil glands* numerous and usually clearly visible. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 2–10 mm long; *pedicels* 7–15 mm long; intermediate internode single, 1–2 mm long; basal internode 2–4 mm long. *Mature buds* pyriform, 4–5 mm long, 3–4 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 8–10 mm long, 6–8 mm diam. Fig. 101.

Flowering: Sep–Nov.

C. kombolgiensis has a wide but sporadic distribution across the northern parts of the Northern Territory, north of 14°S, extending onto islands of the Gulf of Carpentaria (Fig. 102).

Locally abundant in sclerophyllous savannah woodlands on skeletal soils around siliceous sandstone outcrops.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 31 examined): Northern Territory: Nabarlek, *Hinz R 91*, 5 Dec 1988 (DNA, CANB, K, MEL, MO, NSW); Oenpelli, *Brock 31*, 16 Oct 1984 (DNA, NSW); E of Oenpelli, *Johnson 8150*, 23 Sep 1975 (NSW); East Alligator border store, *Brooker 5356*, 2 Oct 1976 (CANB, NSW); 72.1 km from Maningrida to Ramingining road on Oenpelli road, *Hill 4003 & Stanberg*, 1 Sep 1991 (NSW, CANB, DNA); Bluetongue Dreaming, near Nourlangie Rock, *Johnson 8165*, 22 Sep 1975 (NSW, BRI, CANB, DNA); Deaf Adder Gorge, *Boland 2161 & Wardman*, 18 Nov 1984 (CANB, NSW); 34.5 km from Rum Jungle towards Litchfield Park, *Hill 3323, Johnson & Stanberg*, 16 Nov 1988 (NSW, BRI, DNA); UDP Falls, *Bowman 103*, 19 Oct 1984 (DNA, CANB, NSW); 8.1 km W of Flat Rock Creek crossing, *Hill 3962 & Stanberg*, 27 Aug 1991 (NSW, CANB, DNA); Bickerton Island, *Wightman 2396 & Clarke*, 7 Nov 1985 (DNA, CANB, NSW); Umbrawarra Gorge, *Hill 896, Johnson & Benson*, 14 July 1984 (NSW); c. 5 miles [8 km] NW of Katherine on Stuart Highway, *Adams 949*, 10 Apr 1964 (CANB, NSW); NE of Maranboy police station, *Brooker 4170, 4171*, 18 Oct 1973 (CANB, NSW); gap 16 miles [26 km] E of Goomadeer River, *Stocker C10*, 24 Aug 1963 (CANB); 164.1 km from Stuart Hwy on Roper Hwy, *Hill 4126 & Stanberg*, 25 Sep 1991 (NSW, CANB, DNA); NE Centre Island, Pellew Group, *Latz 10679*, 21 July 1988 (DNA, CANB, MEL, NSW).

ACUH Series Polysciadae

Bark on lower trunk persistent (except in *C. torta* subsp. *torta* and often subsp. *allanii*, and in those cases usually discernible near ground level) and regularly tessellated. Leaves dull or somewhat glossy (especially in *C. torta*), oil glands present but obscured in intermediate and adult leaves. Bristle-glands not bearing simple hairs, present on intermediate but not adult shoots and leaves. Abaxial surfaces of leaves not distinctly papillose (except sometimes in early intermediate leaves). Adult leaves broad- to narrow-lanceolate, never cordate (intermediate leaves ovate but not cordate). Inflorescences at flowering mainly on leafless portions of branchlets, condensed, penultimate internodes (peduncles) from greatly elongated to much reduced, pedicels from greatly elongated to rather short.

Two disjunct species in monsoonal regions of the Northern Territory and Western Australia, on moderately to very nutrient-poor, 'harder' sites than those usual for series *Confertiflorae* (Fig. 103). The series may form a clade with *Kombolgienses*, the two then being treatable as subseries.

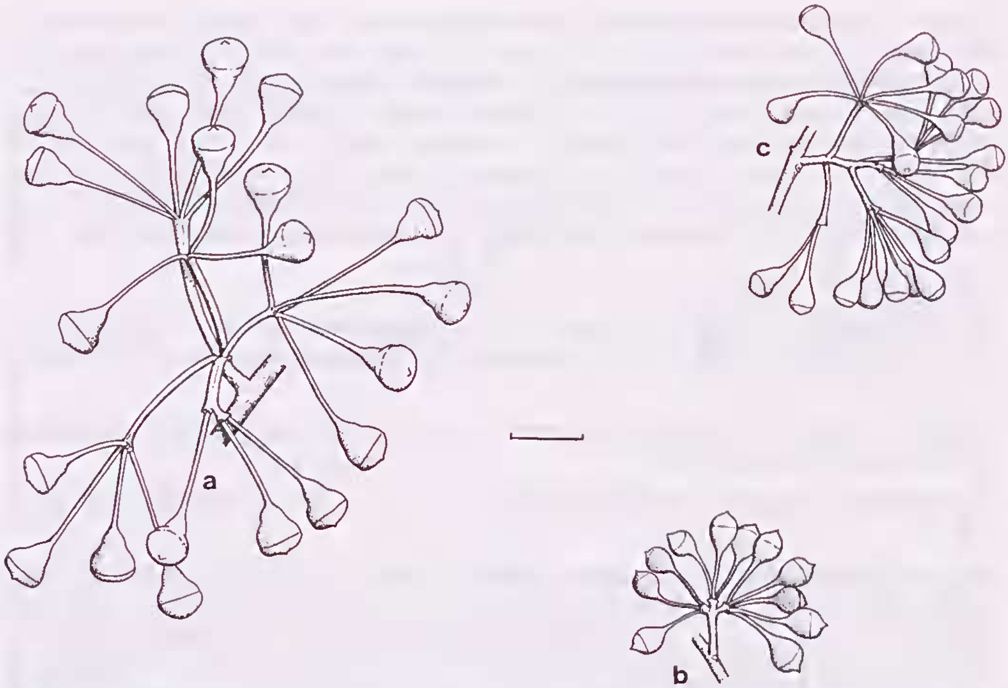

Fig. 101. Inflorescences of. a, *C. polysciada* (from *Johnson 8162*). b, *C. gilbertensis* (from *Johnson & Pryor NSW 301790*). c, *C. kombolgiensis* (from *Brock 31*).

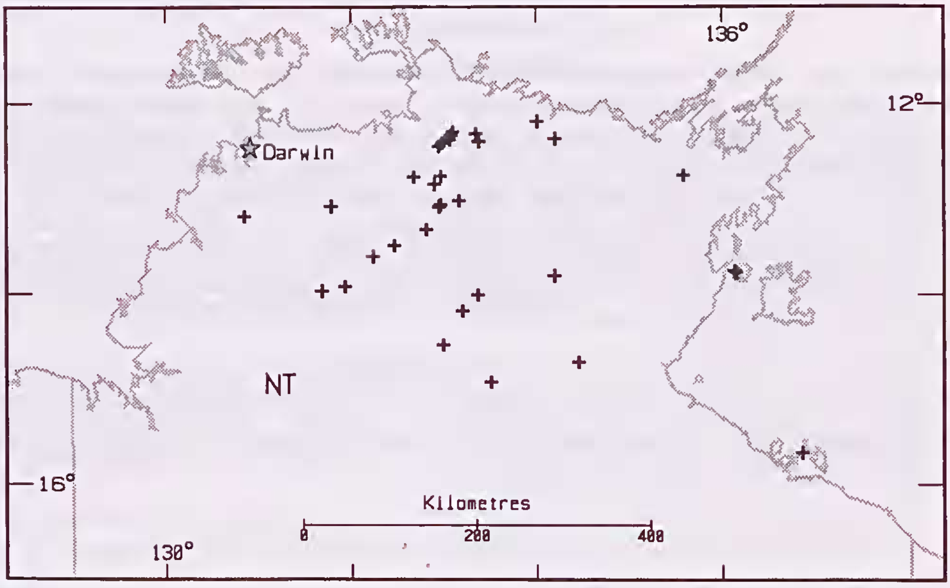

Fig. 102. Distribution of *C. kombolgiensis*.

94. ACUHHA **Corymbia polysciada** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus polysciada* F. Muell., J. Linn. Soc., Bot. 3: 98 (1859).

Type citation: 'Hab. In collibus apricis lapidosis et planitiebus aridis prope M'Adam Range. Anth. vere.'

Type: Northern Territory: Fitzmaurice River, *F. Mueller*, Oct 1855 (holo MEL; iso K). Figured by Blake (1953: plate 11). Synonymised with *E. clavigera* by Bentham (1867) and by Blake (1953). The latter author determined a number of specimens in BRI as *E. polysciada*, but sank this name in his published treatment.

Tree to 15 m (or perhaps more). *Bark* smooth, white, shedding in thin scales, with a sharply defined, dark grey, tessellated persistent stocking. *Juvenile leaves* (late stages only seen, in coppice) cordate at the base, sparsely setose with bristle-glands, simple hairs absent (at stages observed). *Intermediate leaves* opposite, bristle-free, broad-lanceolate to elliptical, acute, to 28 cm long, 100 mm wide; *petioles* to 30 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, lanceolate to broad-lanceolate, acute, 6–18 cm long, 10–40 mm wide; *petioles* 8–32 mm long; *oil glands* sparse, obscured. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* (2-)10–38 mm long; *pedicels* (8-)15–32 mm long; intermediate internode single, 0–3 mm long; basal internode 1–5 mm long. *Mature buds* pyriform to clavate; 5–7 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* ovoid, 9–15 mm long, 8–11 mm diam. Fig. 101.

Flowering: Sep–Nov.

Distinguished within the series by the combination of the narrow adult leaves and the distinct and sharply demarcated stocking on the trunk. Peduncles and pedicels are generally longer than those of the closely related *C. torta*, although some overlap occurs in extreme cases, and fruits are larger. New foliage is often conspicuously pink to claret-coloured.

C. polysciada is widespread and locally frequent, in moister monsoon savannah woodlands of the Northern Territory, north from near Mataranka (Fig. 103). Not recorded from the north-east of the Northern Territory, except for a single record from Groote Eylandt, nor (apart from the type collection) from the range country south-west of the Daly River. The habitat ranges from stony ridges of metamorphics to gravelly laterite plains, usually not including the more fertile alluvial plains.

Hybrids (interserial) are known with *C. arafurica*, *C. pauciseta* and *C. disjuncta* (q.v.) (Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 53 examined): Northern Territory: Murgenella, De Courcy Head, *Russell-Smith 3697 & Lucas*, 22 Oct 1987 (DNA, NSW); Poonali road, S of Pickertaramoor, Melville Island, *Brooker 3231*, 29 June 1971 (CANB, NSW); Oenpelli, *Specht 1302*, 29 Oct 1948 (CANB, NSW); Arnhem Highway, c. 8 km E of Humpty Doo, *Johnson 8162*, 22 Sep 1975 (NSW, CANB, DNA); 12 miles [19 km] W of Mt Bundy mine, *Dunlop 1872*, 5 Sep 1970 (DNA, NSW); 75 km S of Darwin on Stuart Highway, *Hill 909, Johnson & Benson*, 20 July 1984 (NSW, CANB, DNA, PERTH); on road from Batchelor to Litchfield Park, *Blaxell 88/150, 88/151 & Wrigley*, 28 July 1988 (NSW, DNA); 21 miles [34 km] ENE of 'Tipperary' homestead, *Lazarides 6693*, 28 July 1961 (CANB, NSW); 5.5 km from turnoff towards Labelle Downs homestead at 13°08'S 130°37'E, *Hill 4044 & Stanberg*, 8 Sep 1991 (NSW, CANB, DNA); Hemple Bay, Groote Eylandt, *Specht 327A, B, C*, 30 Apr 1949 (BRI); near Umbrawarra Gorge, *Johnson 8159*, 24 Sep 1975 (NSW); 9 miles [14 km] ESE of 'Oolloo' homestead, *Lazarides 6705*, 5 Aug 1961 (CANB, NSW); about 49 miles [78 km] by road NE of Maranboy police station, *Brooker 4166*, 18 Oct 1973 (CANB, NSW); E of Katherine Agricultural College, *Hill 3312, Johnson & Stanberg*, 12 Nov 1988 (NSW); c. 30 km SW of Katherine, *Hill 3298, Johnson & Stanberg*, 11 Nov 1988 (NSW).

95. ACUHHI **Corymbia torta** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

C. polysciadae affinis sed ab ea combinatione characterum sequentium distinguitur: inflorescentiae reductae, alabastra fructusque minores, folia plerumque minora, et cortex tessellatus basalis plerumque minus definitus vel absens.

Type: Western Australia: near Mt Jameson, upper Drysdale River (c. 4 km N of Fig Tree Jumpup), *K.D. Hill 4106 & L. Stanberg*, 19 Sep 1991 (holo NSW; iso BRI, CANB, DNA, PERTH).

Tree to 15 m. *Bark* smooth, white, shedding in thin scales, sometimes with a persistent though irregular stocking of tessellated bark (especially in northern populations). *Intermediate leaves* opposite, sparsely setose with bristle-glands but lacking simple hairs, linear to broad-lanceolate or ovate, acute, rounded or apiculate, to 23 cm long, to 150 mm wide; *petioles* to 15 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, more or less glossy, twisted, narrow-lanceolate to lanceolate, acuminate, 7–17 cm long, 8–35 mm wide; *petioles* 7–17 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 0–12 mm long; *pedicels* 2–10 mm long; intermediate internodes reduced; basal internode 0–4 mm long. *Mature buds* pyriform, 5–6 mm long, 3–4 mm diam.; *calyptra* 1/4–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 6–9 mm long, 5–7 mm diam. Figs 104–106.

Distinguished from *C. polysciada* by the more reduced inflorescences, the smaller buds and fruits, the usually smaller leaves, and the lack of the clearly-defined stocking (the stocking, when present, is often irregular and patchy).

C . *torta* occurs in the central, northern and western parts of the Kimberley region of Western Australia, from the sandstone plateaux of the King Leopold Range north to the Carson River and north-west to the coast (Fig. 103).

Restricted to shallow or skeletal sandy soils on hard siliceous sandstones or granites. Locally often abundant, but in remote and relatively inaccessible regions.

The epithet is from the Latin *tortus*, twisted, in reference to the undulating margins of the adult leaves, which give them a twisted appearance.

Three geographic subspecies can be recognised, of which subsp. *mixtifolia* shows most plesiomorphic features (closest to C. *polysciada*) and subsp. *torta* shows most apomorphies.

1 Pedicels less than 7 mm long .... 95A. subsp. **torta**

1* Pedicels more than 8 mm long

  2 Peduncles less than 4 mm long .... 95B. subsp. **allanii**

  2* Peduncles more than 6 mm long .... 95C. subsp. **mixtifolia**

95A. ACUHHIC **Corymbia torta** *K.D. Hill & L.A.S. Johnson* subsp. **torta**

Tree to 15 m. *Bark* smooth throughout, white, shedding in thin scales. *Intermediate leaves* opposite, setose with bristle-glands, linear to lanceolate, acute, to 17 cm long, to 60 mm wide; *petioles* 8–15 mm long. *Adult leaves* disjunct, twisted, narrow-lanceolate to lanceolate, acuminate, 7–17 cm long, 11–21 mm wide; *petioles* 7–17 mm long. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 0–2 mm long; *pedicels* 2–5(–7) mm long; intermediate internodes reduced; basal internode 1–4 mm long. *Mature buds* pyriform, 5–6 mm long, 3–4 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 6–8 mm long, 5–7 mm diam. Fig. 104.

Flowering: Nov.

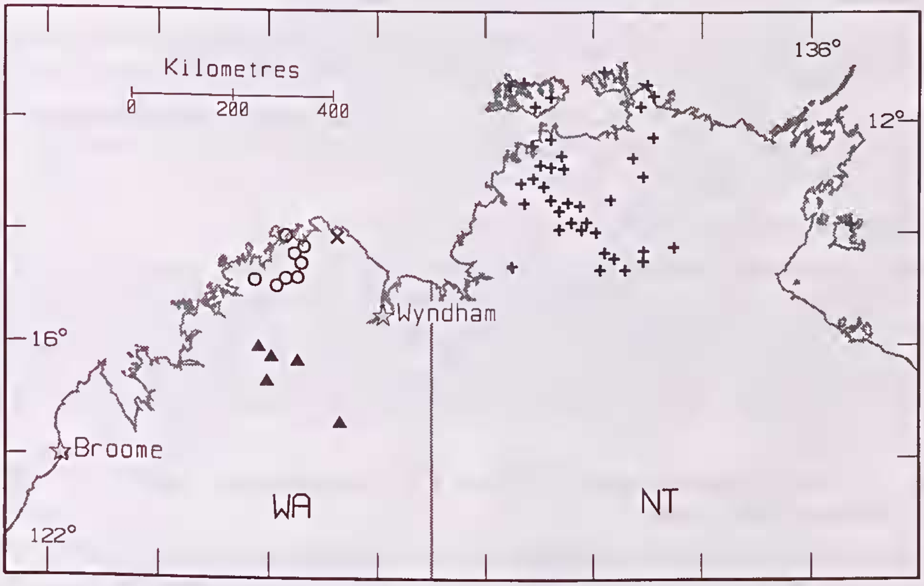

Fig. 103. Distribution of C. *polysciada* (plus), C. *torta* subsp. *torta* (solid triangle), subsp. *allanii* (circle), subsp. *mixtifolia* (cross).

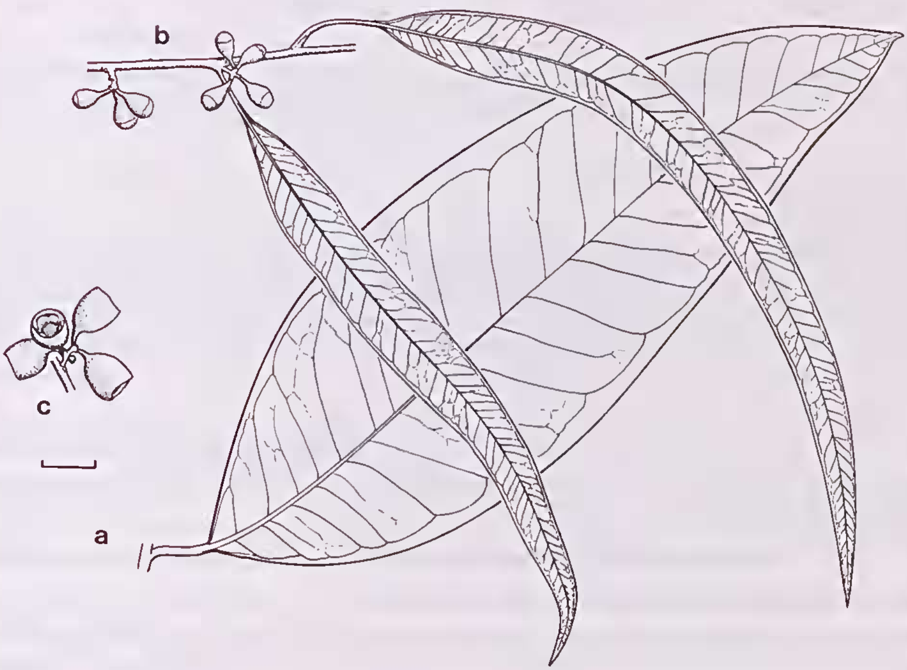

Fig. 104. C. *torta* subsp. *torta* a, intermediate leaf. b, adult leaves, inflorescences and buds. c, fruits (a from *Hill 967 et al.*, b, c from *Hill 3397 et al.*). Scale bar = 1 cm.

Distinguished among the subspecies by the shorter pedicels, the relatively broader fruits, and the more rapid development of adult foliage.

Subspecies *torta* occurs in the central Kimberley region, from the Durack and King Leopold Ranges and northwards, but does not extend into the wettest areas (Fig. 103).

Restricted to shallow or skeletal sandy soils on hard siliceous sandstones, frequently around eroded edges of relict Tertiary land surfaces. It is locally abundant, but largely in rather relatively inaccessible parts.

Conservation status: Not considered to be at risk.

Specimens examined: Western Australia: 82.7 km NE of 'Mt Barnett' station on Gibb River Road, *Hill 3402, Johnson & Stanberg*, 21 Nov 1988 (NSW); Manning Gorge camping area, 'Mt Barnett' station, *Hill 3397, Johnson & Stanberg*, 20 Nov 1988 (NSW); 42 km NW of 'Mt Elizabeth' new homestead, *Brooker 7760*, 30 Oct 1982 (CANB, NSW); 25.3 km NW of old 'Mt Elizabeth' homestead on track to 'Panter Downs', *Hill 967, Johnson & Benson*, 27 July 1984 (NSW); cliffs to SW of 'Elgee Jumpup' (17°23'S 127°16'E), *Hill 3477, Johnson & Stanberg*, 26 Nov 1988 (NSW, CANB, PERTH).

95B. ACUHHIJ **Corymbia torta** *K.D. Hill & L.A.S. Johnson* subsp. **allanii** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Inter subspecies *C. tortae* combinatione characterum sequentium distinguitur: pedunculi breviores, pedicelli longiores, fructus aequidimensionales, cortex plerumque non persistens, folia adulta cum foliis intermediis non admixta.

Type: Western Australia: carpark at Mitchell Falls track, *K.D. Hill 3410, L.A.S. Johnson & L. Stanberg*, 21 Nov 1988 (holo NSW; iso BRI, CANB, DNA, PERTH).

Tree to 15 m. *Bark* smooth, white, shedding in thin scales, sometimes with some irregular persistent tessellated bark on the lower trunk. *Intermediate leaves* opposite, setose with bristle-glands, broad-lanceolate to ovate, acute, to 15 cm long, to 100 mm wide; *petioles* to 9 mm long. *Adult leaves* disjunct, rather glossy, twisted, narrow-lanceolate to lanceolate, acuminate, 7–16 cm long, 8–22 mm wide; *petioles* 7–14 mm long. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 0–2 mm long; *pedicels* 8–10 mm long; intermediate internodes reduced; basal internode 1–4 mm long. *Mature buds* pyriform, 5–6 mm long, 3–4 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 7–9 mm long, 5–6 mm diam. Fig. 105.

Flowering: Nov.

Distinguished by the longer pedicels but short peduncles, the relatively narrower fruits, and lack of the tendency to retain intermediate foliage in the canopy. Trees frequently show some irregularly persistent tessellated bark on the lower trunk, particularly in older and larger individuals. The characters are generally intermediate between those of the other two subspecies, but subsp. *allanii* is reasonably consistent over a considerable range.

Subspecies *allanii* occurs in the central-northern Kimberley region, from the sandstone edges of the Mitchell Plateau eastward to the Carson River and possibly beyond (Fig. 103).

Restricted to shallow or skeletal sandy soils on hard siliceous sandstones or granites.

Conservation status: Not considered to be at risk.

The epithet commemorates the botanist Allan Cunningham, who first collected the taxon in 1819 while on one of Philip Parker King's surveys of the Australian coast.

Selected specimens (from 11 examined): Western Australia: Vansittart Bay, *Cunningham 453*, Oct 1819 (NSW ex K); Vansittart Bay, *Gardner 1530*, 14 Aug 1921 (NSW ex PERTH); road from

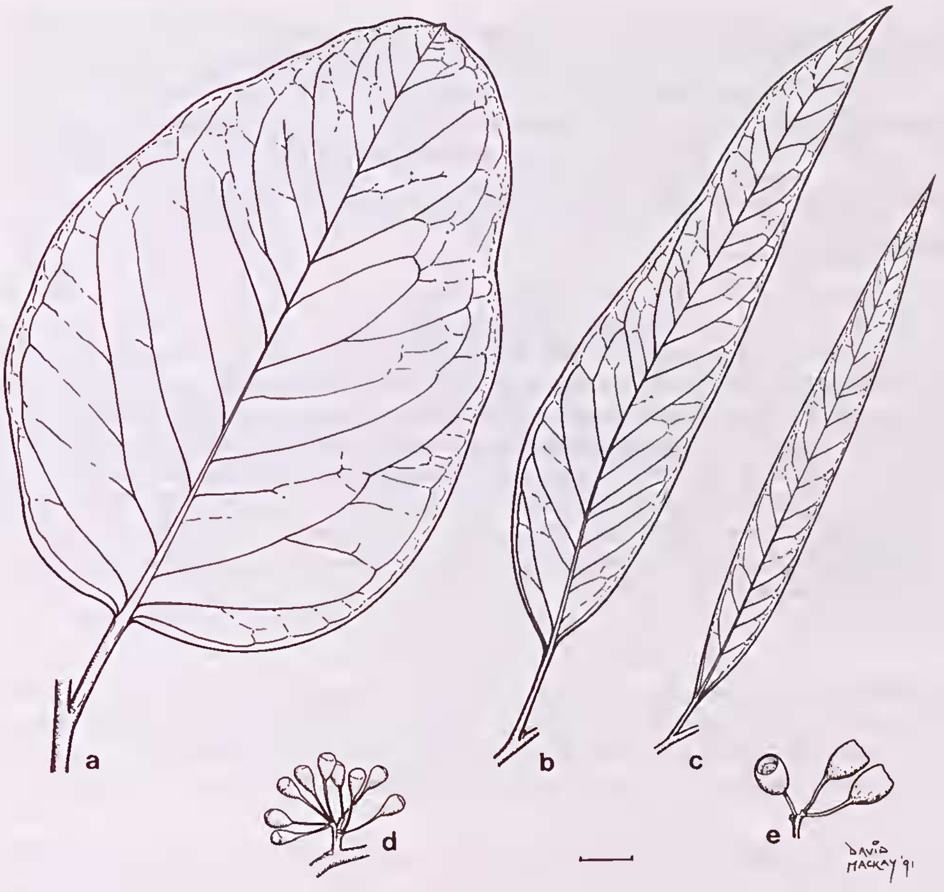

Fig. 105. *C. torta* subsp. *allanii* a, intermediate leaf. b, c adult leaves. d, inflorescence and buds. e, fruits (a, b, d from *Hill 3409 et al.*, c, e from *Hill 951 et al.*). Scale bar = 1 cm.

Kalumburu to old landing, *Hill 963, Johnson & Benson*, 26 July 1984 (NSW); 20 miles [32 km] SW of Kalumburu, *Speck 4921*, 5 Sep 1954 (CANB, BRI); 16.3 km S of Carson River crossing on Gibb River Road, *Hill 4099 & Stanberg*, 17 Sep 1991 (NSW, CANB, PERTH); carpark at Mitchell Falls track, *Hill 3409, Johnson & Stanberg*, 21 Nov 1988 (NSW); gauging station on Morgan River, near 'Theda' homestead, *Hill 951, Johnson & Benson*, 27 July 1984 (NSW); King Edward River, at crossing of track to Mitchell Plateau, *Hill 3405, Johnson & Stanberg*, 21 Nov 1988 (NSW, BRI, CANB, DNA, PERTH); near King Edward River, *Done 327*, 15 Oct 1980 (DNA).

95C. ACUHHIM **Corymbia torta** *K.D. Hill & L.A.S. Johnson* subsp. **mixtifolia** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Inter subspecies *C. tortae* combinatione characterum sequentium distinguitur: pedunculi et pedicelli longi, fructus aequidimensionales, cortex tessellatus basalis persistens, folia adulta latiora, cum foliis intermediis frequenter mixta.

Type: Western Australia: 1.0 km N of Carson River to King George River track (14°06'S 127°13'E), *K. Hill 956, L. Johnson & D. Benson*, 25 July 1984 (holo NSW; iso CANB, DNA, PERTH).

Tree to 15 m. *Bark* smooth, white, shedding in thin scales, with an often irregularly and patchily persistent tessellated stocking. *Intermediate leaves* opposite, sparingly setose with bristle-glands, ovate to elliptical, rounded or apiculate, to 23 cm long, 150 mm wide; *petioles* 7–15 mm long. *Adult leaves* disjunct, narrow-lanceolate to lanceolate, acuminate, 9–15 cm long, 10–35 mm wide; *petioles* 8–12 mm long. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 7–11 mm long; *pedicels* 7–10 mm long; intermediate internodes reduced; basal internode 0–3 mm long. *Mature buds* pyriform; c. 6 mm long, c. 4 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* ovoid, 6–7 mm long, 6–7 mm diam. Fig. 106.

Flowering: Not recorded.

Distinguished by the long pedicels and peduncles, the equidimensional fruits, the tendency to retain intermediate foliage in the canopy, and the usually persistent although often irregular stocking on the lower 1/2 to 1/4 of the trunk. In both this and subspecies *allanii* the mature canopy may retain several ontogenetic leaf-stages, not necessarily in a regular developmental order along a particular branch. This is caused by a partial or complete retention of canopy leaves beyond one season, and subsequent ontogenetic reversion on new shoots developed in the next season. Such reversion occurs in many species in section *Blakearia*, but most of these species shed the majority of the canopy leaves each season. In all cases, flowering is not restricted to fully 'adult' stages, and quite juvenile leaf-forms may occur farther along a branch that bears flowers.

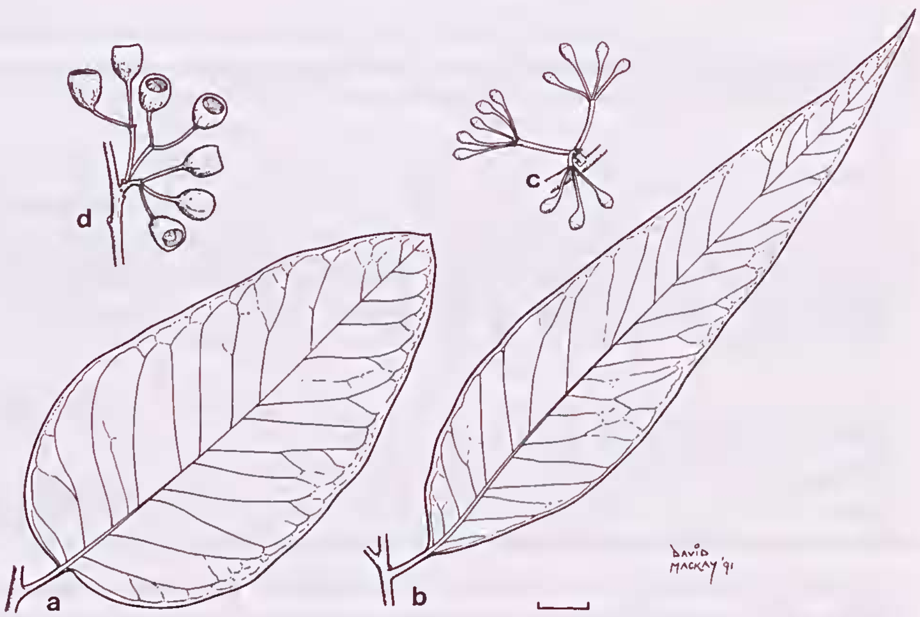

Fig. 106. *C. torta* subsp. *mixtifolia* a, intermediate leaf. b, adult leaf. c, inflorescence and buds. d, inflorescence and fruits (a, d from *Hill 956*, b, c from *Brooker 7769*). Scale bar = 1 cm.

Subspecies *mixtifolia* has been found only in the far northern Kimberley region, near the lower reaches of the Drysdale River north-east of Kalumburu (Fig. 103). Apparently restricted to shallow or skeletal sandy soils on hard siliceous sandstones.

Conservation status: Known from only two sites, probably part of one population. Possibly rare, but occurring in an extremely remote area. 2K.

Selected specimens (from 4 examined): Western Australia: 16 km NNE of Carson River to King George River track (14°03'S 127°16'E), *Brooker 7769*, 1 Nov 1982 (CANB, NSW); 0.9 km N of Carson River to King George River road, 28 km E of Barton River, *Hill 960, Johnson & Benson*, 25 July 1984 (NSW).

ACUI Series **Confertiflorae**

Bark on lower trunk persistent (except in some small individuals of *C. dendromerinx*) and regularly tessellated; smooth above. Leaves dull, oil glands present but obscured in intermediate and adult leaves. Bristle-glands (with or without simple hairs) abundantly present on intermediate shoots and leaves, and mostly so on adult leaves also. Intermediate leaves, and, less prominently, often adult leaves with all epidermal cells on the abaxial surface bulging to form short papillae. Adult leaves ovate to broad-ovate, often cordate, ± discolorous but amphistomatic. Inflorescences at flowering mainly on leafless portions of branchlets, condensed, penultimate internodes (peduncles) moderately elongated to considerably reduced in length, sometimes branched, pedicels at least moderately elongated.

Five species, all tropical, occur with a replacement pattern in northern Australia and some drier parts of southern Papua New Guinea (Fig. 107), generally on less 'hard' country than those of *Kombolgienses*, *Polysciadae* and the following series except *Grandifoliae*. All species are facultatively deciduous in the regular monsoon 'dry season'.

This and the following two series may constitute a clade, and could then be treated as three subseries.

96. ACUIIA **Corymbia disjuncta** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Confertiflorarum* combinatione characterum sequentium distinguitur: folia adulta lata, orbicularia, plerumque setosa, distincte petiolata; regio corticis persistentis regularis, ad partem superiorem trunci extendens; setoglandulae sine trichomatibus simplicibus.

Type: Northern Territory: 6 km from Stuart Highway on road to Stapleton, *J.D. Briggs 842*, 3 May 1983 (holo NSW; iso CBG, DNA).

Tree to 15 m (or taller). *Bark* smooth, white to silver-grey, shedding in thin scales, with a clearly defined, persistent, tessellated, grey stocking on the lower to full trunk. *Intermediate leaves* opposite, setose with bristle-glands lacking simple hairs, ovate to orbicular, apically rounded to obtuse, cordate, persistent into mature canopy, 15–35 cm long, 100–200 mm wide; *petioles* 15–25 mm long. *Adult leaves* opposite or subopposite, discolorous, minutely papillose beneath, amphistomatic, elliptical to orbicular, apically rounded, basally rounded or cordate, 6–18 cm long, 60–150 mm wide; *petioles* 10–40 mm long; *oil glands* abundant but obscure. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 3–18 mm long; *pedicels* 19–35 mm long; intermediate internode single, 1–7 mm long; basal internode 3–5 mm long. *Mature buds* pyriform, 7–8 mm long, 5–6 mm diam.; calyptra about 1/3 as long as hypanthium. *Fruits* ovoid, 9–13 mm long, 7–10 mm diam. Fig. 108.

Flowering: Oct–Nov.

Distinguished within the series by the combination: adult leaves broad, orbicular, usually setose, distinctly petiolate; stocking regular, persistent, extending to upper trunk; bristle-glands not bearing simple hairs. Peduncles and pedicels are generally longer than those of C. *confertiflora*, and fruits smaller. Flowering also occurs later in the season. New foliage is often dark red or purple in colour.

Blake (1953) noted that some of the forms that he referred to *E. confertiflora* had distinctly petiolate adult leaves, but did not recognise a regional replacement distribution pattern. He thought that the two forms graded together more or less indiscriminately, and he consequently regarded them as minor variants of no taxonomic significance.

This species has several disjunct occurrences through the wet monsoon tropics, from the north-western Kimberley to the north-western Northern Territory, and in northern Cape York Peninsula in Queensland, into Papua New Guinea in the Western and Central Districts (Fig. 107). C. *disjuncta* is apparently absent from much of Arnhem Land, being replaced by C. *pauciseta*. Both species occur in similar lowland sites, in open savannah communities on seasonally wet flats.

Intergradation occurs with C. *pauciseta* in northern Arnhem Land, and with C. *confertiflora* to the south of Arnhem Land (contact areas but not plotted in Fig. 107, see Appendix 1). Extensive hybridism occurs with C. *papuana* in the vicinity of Port Moresby, and east of there, in Papua New Guinea. Hybrids are also recorded with C. *arafurica* – C. *bella* intergrades, C. *arafurica* and C. *polysciada* (Appendix 1).

The epithet is from the Latin *disjunctus*, disjointed, referring to the distribution pattern.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

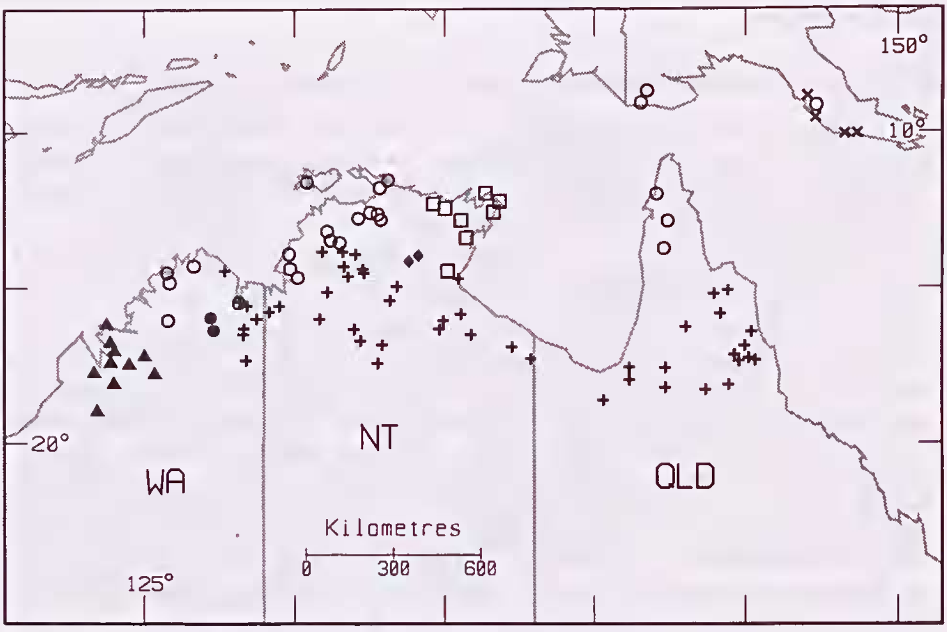

Fig. 107. Distribution of C. *disjuncta* (open circle), C. *pauciseta* (square), C. *confertiflora* (plus), C. *karelgica* (solid circle), C. *dendromerinx* (triangle), C. *disjuncta* X C. *papuana* (oblique cross), C. *confertiflora* – C. *pauciseta* (diamond).

Selected specimens (from 36 examined): Western Australia: near Mt Jameson, upper Drysdale River (c. 4 km N of Fig Tree Jumpup), *Hill 4107 & Stanberg*, 19 Sep 1991 (NSW, CANB, PERTH); mining campsite, Mitchell Plateau, *Kenneally 8605*, 15 Oct 1982 (PERTH, NSW); Mitchell River Plateau, *Johnson 2070*, 26 Aug 1967 (NSW); 48 miles [77 km] SSE of Kalumburu mission, *Speck 4853*, 1 Sep 1954 (CANB, DNA); base of hill on track to Five Rivers Lookout, Wyndham, *Hill 4073 & Stanberg*, 14 Sep 1991 (NSW, CANB, PERTH).

Northern Territory: Bathurst Island, *Jacobs*, 24 June 1933 (NSW 21491); 23.7 miles [38 km] SE of Mountnorris Bay, *Chippendale NT 8130*, 17 July 1961 (DNA, NSW); Wurrmalmirr Creek, Elcho Island, *Dunlop 3854*, 6 July 1975 (DNA, CANB); Jabiru township, *Boland 2181 & Wardman*, 20 Nov 1984 (CANB, NSW); Wildman River crossing, Arnhem Highway, *Benson 951*, 11 July 1974 (NSW); 91 miles [145 km] from Darwin towards Katherine, *Brooker 4159*, 16 Oct 1973 (CANB, NSW); 54.9 km E of Gan Gan turnoff, *Hill 3947 & Stanberg*, 26 Aug 1991 (NSW, CANB, DNA); near Darwin road, 32 miles [51 km] SE of Adelaide River township, *Perry 3206*, 11 Sep 1952 (CANB, DNA).

Queensland: 37 miles [59 km] N of Moreton telegraph station, *Gittins 1868*, Aug 1968 (NSW); 79 km SE of Weipa, *Benson 596*, 8 Oct 1973 (NSW); 20 km E of Kawaha Lagoon on track to Merapah, *Clarkson 4574*, 17 Oct 1982 (BRI, CANB, NSW, QRS).

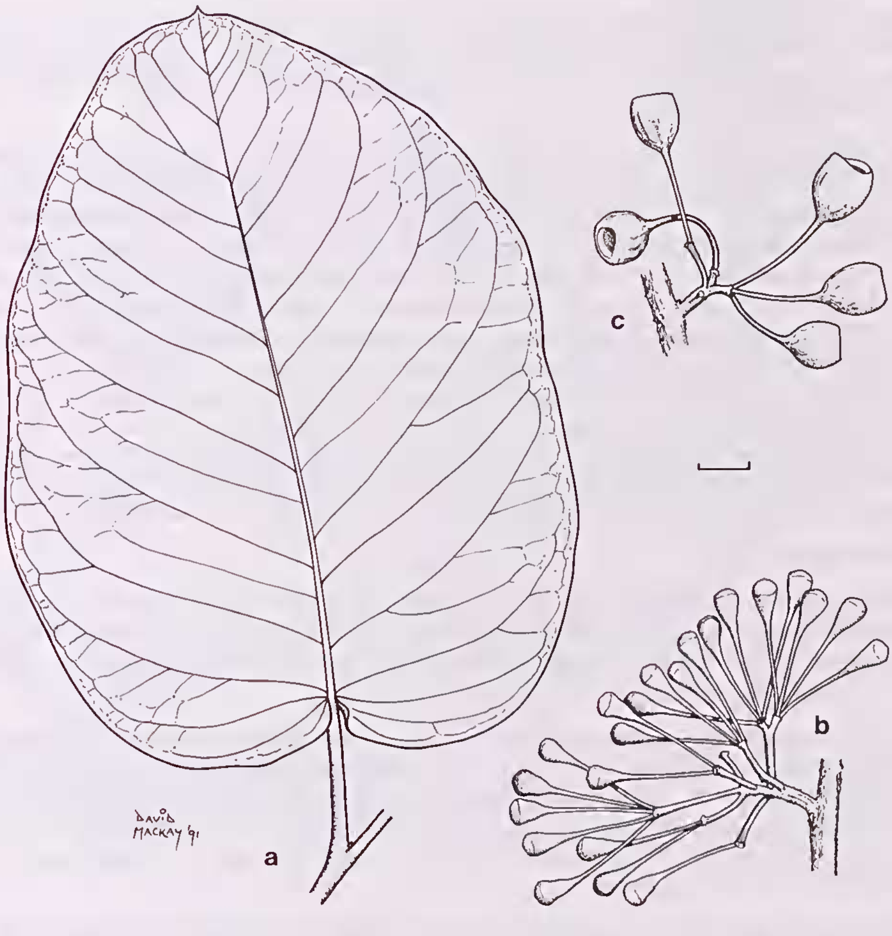

Fig. 108. C. *disjuncta*. a, adult leaf. b, inflorescence and buds. c, inflorescence and fruits (a, b from *Kenneally 8605*, c from *J. Briggs 842*). Scale bar = 1 cm.

Papua New Guinea: 4 miles [6 km] E of Morehead, *Pryor*, 1 Aug 1979 (CANB, NSW 301692, 301694); near Tonda village, S of Morehead, *Henty & Foreman NGF 49431*, 15 Nov 1972 (LAE, NSW); Tarara, Wassi Kussa River, Western District, *Brass 8568*, Dec 1936 (NSW); Brown River Road, Central District, *Streimann & Kairo NGF 27508*, 10 Feb 1966 (LAE, NSW).

97. ACUIIB **Corymbia pauciseta** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Confertiflorarum* combinatione characterum sequentium distinguitur: folia adulta lata, ovata ad elliptica, plerumque non setosa vel sparsissime setosa, sessilia vel brevissime petiolata; regio basalis corticis regularis et persistens, saepe ad partem superiorem trunci extendens; setoglandulae sine trichomatibus simplicibus.

Type: Northern Territory: Gove, *B. Hyland 7853*, 7 Nov 1974 (holo NSW; iso QRS, DNA).

= *Eucalyptus clavigera* Cunn. ex Schauer var. *diffusa* Blakely & Jacobs in Blakely, Key Eucalypts: 75, plate 152, figs 4, 5, 6a, 6b (1934).

Type citation: '19a. var. DIFFUSA (R. Br. MSS.) Blakely & Jacobs, var. nov.' Blakely also cited a number of localities and collectors, but he annotated a Robert Brown specimen in NSW as 'Type'.

Type: North Coast [Inglis I.], *R. Brown*, [1803] (lecto NSW; isolecto MEL), figured by Maiden (Crit. Rev. Eucalyptus 4: plate 152, fig. 4, 1919), as *E. clavigera*. Blake (1953: 216) discussed and established lectotypification as part of his synonymy of *E. confertiflora*.

Tree to 15 m (perhaps sometimes more). *Bark* smooth, white to silver-grey, shedding in thin scales, with a clearly defined, persistent, tessellated, grey stocking on the lower to full trunk. *Intermediate leaves* opposite, sparsely setose with bristle-glands not bearing simple hairs, ovate to orbicular, obtuse to rounded, cordate, persistent into mature canopy, 12–25 cm long, 80–180 mm wide; *petioles* 2–4 mm long. *Adult leaves* opposite or subopposite, almost bristle-free to sparsely setose with bristle-glands not bearing simple hairs, discolorous, minutely papillose beneath, amphistomatic, broad-lanceolate to ovate or elliptical, apically rounded to obtuse, basally rounded or cordate, 10–17 cm long, 30–90 mm wide; *petioles* 2–5 mm long; *oil glands* largely obscured. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 2–15 mm long; *pedicels* 14–32 mm long; intermediate internode single, 2–7 mm long; basal internode 2–5 mm long. *Mature buds* pyriform, 6–8 mm long, 5–6 mm diam.; calyptra about 1/3 as long as hypanthium. *Fruits* ovoid, 10–15 mm long, 9–12 mm diam. Fig. 109.

Flowering: Oct–Nov.

Distinguished within the series by the combination: adult leaves broad, ovate to elliptical, usually bristle-free or very sparsely setose; adult leaves sessile or very shortly petiolate; stocking regular, persistent, often extending to upper trunk; bristle-glands lacking simple hairs.

A locally frequent but sporadic species in low savannah woodland patches in areas with generally taller forest, on a range of substrates and landforms, usually on flat sites. Restricted to the north-eastern parts of the Northern Territory, mainly in Arnhem Land (Fig. 107). Replaced by *C. disjuncta* to the west and *C. confertiflora* to the south, but perhaps with some overlap with the former. Flowering is later than in *C. confertiflora* where recorded.

Intergrades occur with *C. disjuncta* and *C. confertiflora* where the ranges of the species adjoin (Fig. 107), and hybrids are recorded with *C. arafurica* – *C. bella* intergrades and with *C. polysciada* (Appendix 1).

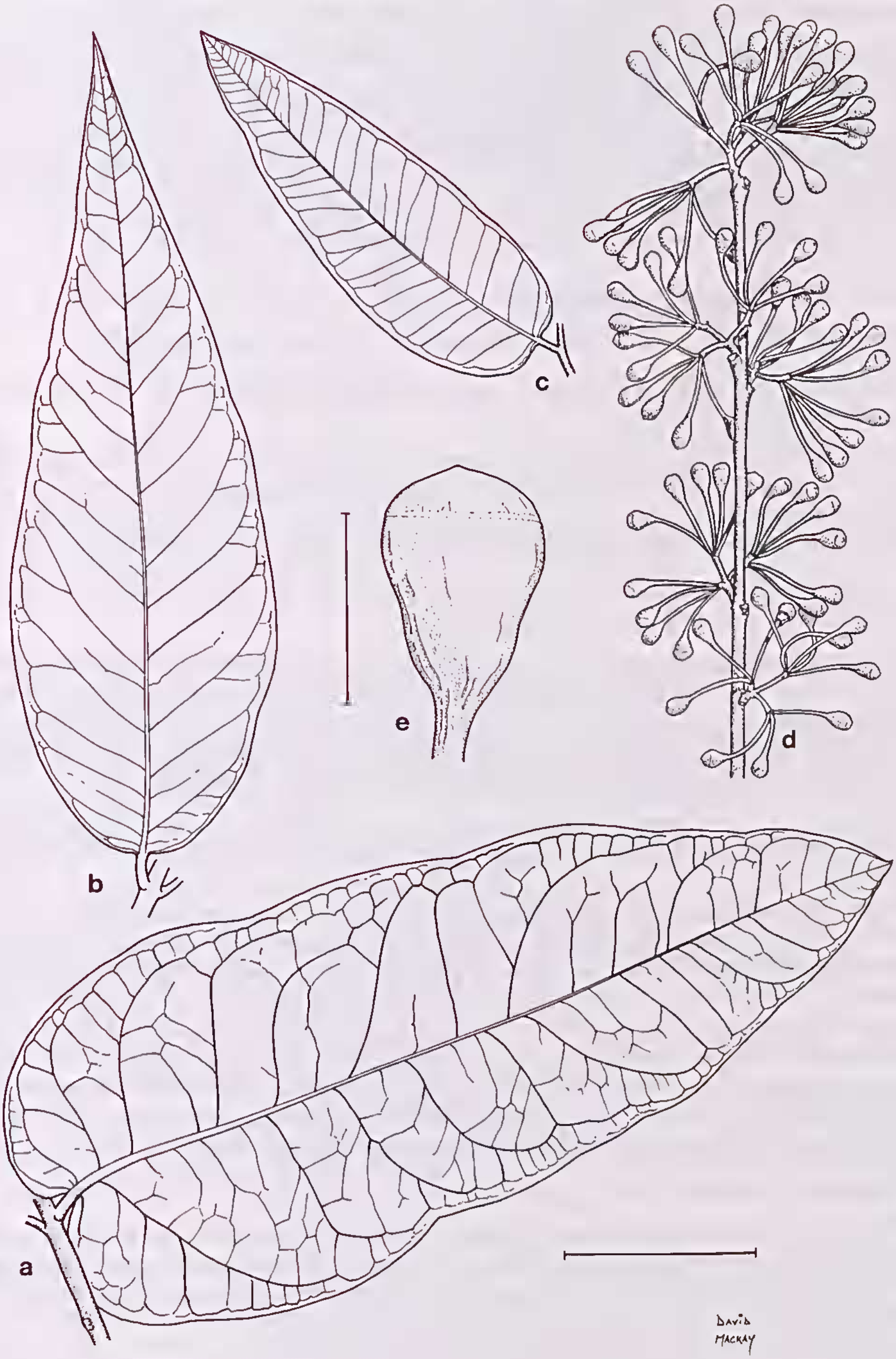

Fig. 109. *C. pauciseta.* a, intermediate leaf. b, late intermediate leaf. c, adult leaf. d, inflorescence, buds and flowers. e, bud (a from *Hill 3931*, b from *Hill 3993*, c, d, e from *Clarke 1650*). Scale bar: a, b, c, d = 4 cm; e = 5 mm.

Conservation status: Not considered to be at risk.

The epithet is from the Latin *paucus*, few, and *seta*, a bristle, referring to the relatively bristle-free leaves and shoots as compared with those of *C. confertiflora*.

Selected specimens (from 15 examined): Northern Territory: Gove Peninsula, Arnhem Land, *Cooper*, Nov 1974 (NSW 301734); road into old Arafura homestead, *Clark 1252*, 24 July 1987 (DNA); mine area, Gove, *Hinz 754*, 1974 (DNA, CANB); Matta Murta River turnoff, Arnhem Land, *Clark 1650*, 10 Oct 1987 (DNA, NSW); Maria Island, Gulf of Carpentaria, *Dunlop 2789*, 12 July 1972 (DNA, NSW); 16.7 km SW [of] Phelp River, Arnhem Land, *Clark 1683*, 12 Oct 1987 (DNA); 64.9 km E of Ramingining turnoff on Gove road (Badalngarrmirri Creek), *Hill 3931 & Stanberg*, 25 Aug 1991 (NSW, CANB, DNA); 7.6 km W of Blyth River crossing on Ramingining to Maningrida road, *Hill 3993 & Stanberg*, 1 Sep 1991 (NSW, CANB, DNA).

98. ACUIIC **Corymbia confertiflora** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus confertiflora* F. Muell., J. Linn. Soc., Bot. 3: 96 (1859).

Type citation: 'Hab. A flumine Victoria ad rivum Gilbert in pascuis siccis proveniens. Anth. Oct., Nov.'

Type: Northern Territory: W of Katherine, *S.T. Blake 17300*, 25 Oct 1946 (neo BRI; isoneo K, MEL, NSW). Blake (1953) established the neotypification, stating that Mueller's original specimen ('Between the Victoria River and the Gilbert River') could not be found. Blake also discussed author citation.

[≡ *E. floribunda* F. Muell., J. Linn. Soc., Bot. 3: 96 (1859), in syn. in nota; non Huegel ex Endl. (1837); nec Tausch ex Maiden (1919).]

E. confertiflora was synonymised under *E. ferruginea* Schauer by Bentham (1867), Maiden (Crit. Rev. Eucalyptus passim, see under section *Blakearia*, above) and Blakely (1934). Blake (1953) perceived that it was a very different species, to which the name *E. clavigera* had been incorrectly applied by the former authors (in part; their concept of *E. clavigera* also included *E. polysciada* and *E. clavigera* sensu stricto).

Tree to 15 m. *Bark* smooth, white to silver-grey, shedding in thin scales, with a clearly defined, persistent, tessellated, grey stocking on the lower to full trunk. *Intermediate leaves* opposite, setose with bristle-glands, which rarely bear a few short simple hairs, ovate to orbicular, obtuse to rounded, cordate, persistent into mature canopy, 12–25 cm long, 80–180 mm wide; *petioles* 2–4 mm long. *Adult leaves* opposite or subopposite, discolorous, minutely papillose beneath, amphistomatic, broad-lanceolate to ovate or elliptical, rounded to obtuse, basally rounded or cordate, 8–17 cm long, 30–90 mm wide; *petioles* 2–5 mm long; *oil glands* sparse, obscured. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 2–15 mm long; *pedicels* 14–25 mm long; intermediate internode single, 2–7 mm long; basal internode 2–5 mm long. *Mature buds* pyriform, 6–7 mm long, 5–6 mm diam.; calyptra about 1/3 as long as hypanthium. *Fruits* ovoid, 11–15 mm long, 9–12 mm diam. Fig. 110.

Flowering: July–Sep(–Oct).

Distinguished by the combination: adult leaves broad, ovate to elliptical, usually setose, sessile or very shortly petiolate; stocking regular, persistent, often extending to upper trunk; bristle-glands not or rarely bearing simple hairs. New foliage is sometimes (but not always) dark red or purple in colour.

Widespread across the monsoon tropics, from the eastern Kimberley region of Western Australia to the Townsville district in Queensland, south to Daly Waters in the Northern Territory (Fig. 107). Replaced by *C. disjuncta* and *C. pauciseta* in wetter parts nearer to the northern coast.

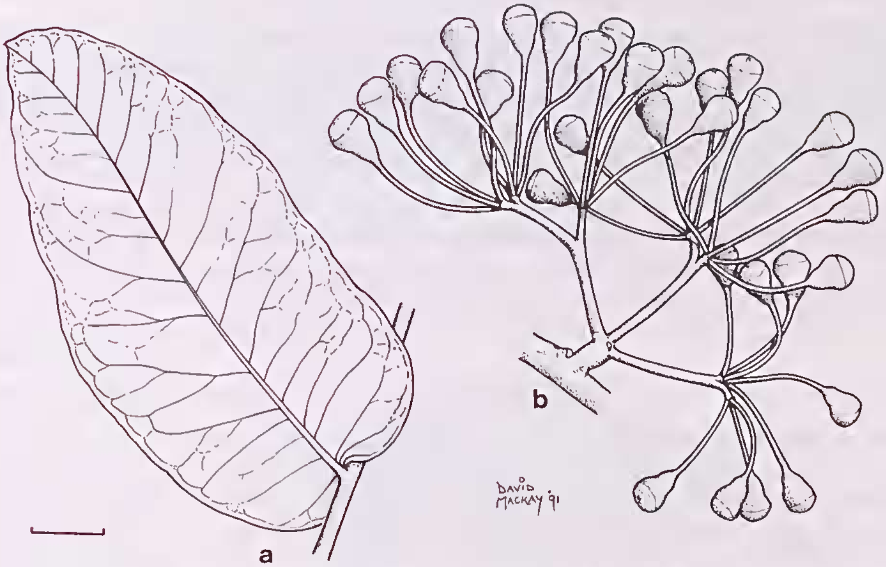

Fig. 110. *C. confertiflora*. a, adult leaf. b, inflorescence and buds. (a, from *Lazarides 6642*, b, from *Spencer NSW 21489*). Scale bar = 1 cm.

A frequent species in low savannah woodland, on a range of substrates and landforms, usually scattered in open woodland on sites of low relief.

Intergrades occur with *C. disjuncta* and *C. pauciseta* where the ranges of the species adjoin (Fig. 107), and hybrids are recorded with *C. bella*, *C. arafurica* – *C. bella* intergrades, *C. chillagoensis*, *C. gilbertensis* and *C. tessellaris* (Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 60 examined): Western Australia: 10 km W of Berkeley River (14°28'S 127°37'E), *Brooker 7777*, 2 Nov 1982 (CANB, NSW); 9-mile Ridge, near Wyndham, *Fitzgerald 8*, Sep 1906 (NSW); Bungle Bungle outcamp, *Kenneally 9261*, 9 July 1984 (PERTH, NSW). 'Dunham River' station, *Gittins 1408*, July 1967 (NSW).

Northern Territory: c. 15 miles [24 km] SW of 'Tipperary' homestead, *Lazarides 6642*, 13 July 1961 (CANB, NSW); Cullen Creek, *Spencer*, July–Aug 1911 (NSW 21489, K); Wyndham road, 6 miles [10 km] SW of Katherine, *Adams 840*, 17 Jan 1964 (CANB, NSW); Roper River valley, *M. Cunningham*, Sep 1967 (NSW); slopes near 'Elsey' station, *Jacobs 119*, 29 July 1933 (NSW); 141.7 km from Port Roper turnoff on Roper Bar to Borroloola road, *Hill 4131 & Stanberg*, 26 Sep 1991 (NSW, CANB, DNA); 19 km N of Top Springs, *Dunlop 4963*, 8 July 1978 (DNA, CANB, NSW); 80.3 miles [130 km] SE of Top Springs, *Chippendale NT 3866 & Johnson*, 4 Oct 1957 (DNA, NSW).

Queensland: Kennedy River, *Turner 476*, 20 Nov 1981 (CANB, NSW); Hann River, 50 miles [80 km] NW of Laura, *Pedley 1862*, 13 Nov 1965 (BRI, NSW); along Highbury to Dunbar road, near Mitchell River, *Jackes*, 1 Oct 1985 (NSW); Mt Mulligan, *Flecker 6462*, 2 Dec 1939 (NSW); Chillagoe, *Doran 15*, 9 Oct 1911 (NSW); Dimbulah to Petford, *Hyland 8041*, 20 Feb 1975 (QRS, NSW); the Ten Mile, Stannary Hills, *Bancroft*, Sep 1909 (NSW); Alma Den, *Cambage 4159*, 19 Aug 1913 (NSW); 44 miles [74 km] N of Croydon township, *Perry 3913*, 5 Aug 1953 (CANB, NSW); 20 miles [32 km] S of Normanton, *Johnson & Pryor*, 20 Oct 1964 (NSW 301702); 40 miles [64 km] S of Mt Garnet on Hughenden road, *Carolin 8579*, 13 Apr 1974 (NSW); 12 miles [19 km] W of the Alexander River crossing on the Cloncurry to Burketown road, *Carolin 8857*, 24 Apr 1974 (NSW).

99. ACUIID **Corymbia karelgica** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Confertiflorarum* combinatione characterum sequentium distinguitur: folia adulta lata, ovata ad elliptica, plerumque setosa, distincte petiolata (petiolis longioribus quam eis *C. dendromeringis*, brevioribus quam eis *C. disjunctae*); regio corticis persistentis regularis maximam partem trunci tegens; cortex laevis pallidus, non vel vix pulviger; setoglandulae trichomata simplicia ferentes; trichomata simplicia etiam ex epidermide enata.

Type: Western Australia: 7 miles [12 km] NE of Karunjie station, *R.A. Perry 3158*, 31 July 1952 (holo NSW; iso CANB).

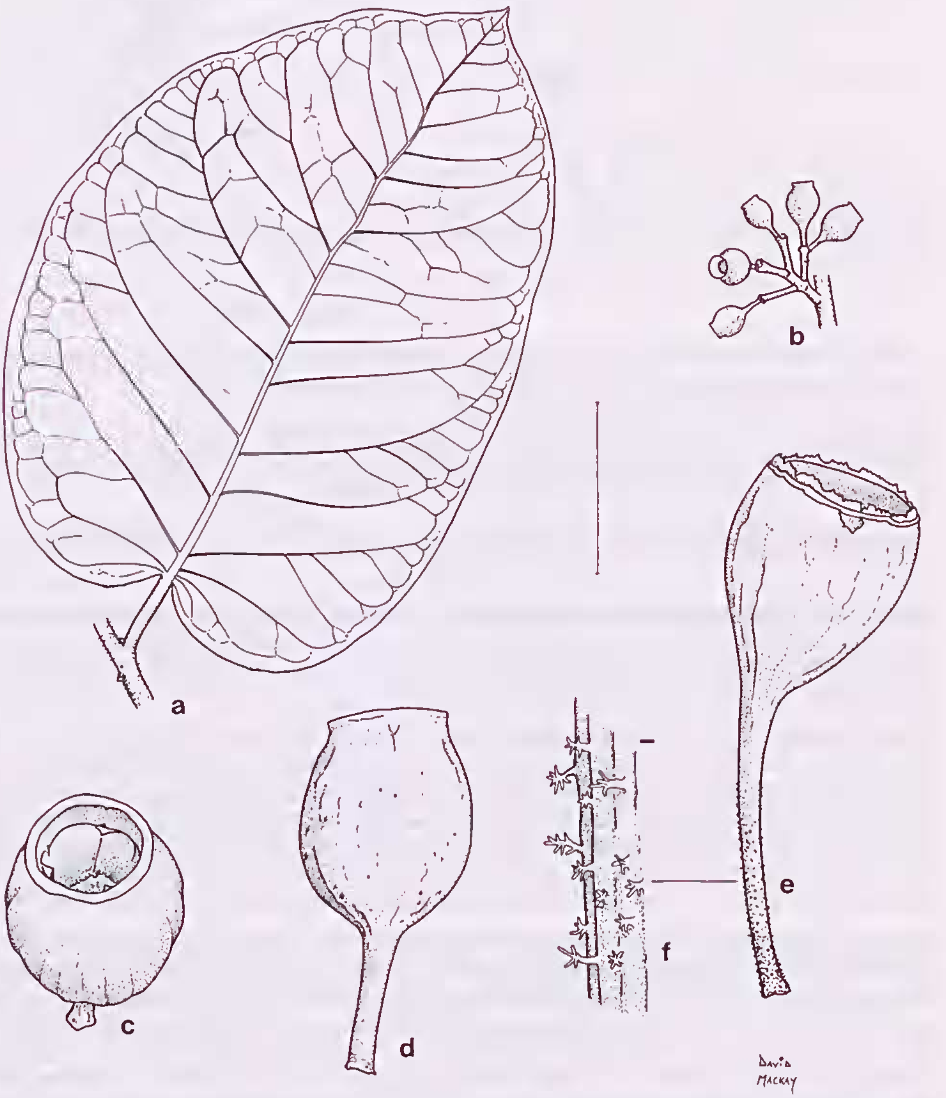

Fig. 111. *C. karelgica*. a, adult leaf. b, inflorescence and fruits. c, d, e, fruit. f, detail of bristles on fruit pedicel (all from *Perry 3158*). Scale bar: a, b = 35 mm; c, d, e = 7 mm; f = 1 mm.

Tree to 12 m. *Bark* smooth, mid- to dark grey, generally not powdery, shedding in thin scales, with a regular, sharply demarcated, persistent tessellated grey stocking on the lower half to full trunk. *Intermediate leaves* opposite, setose with simple-hair-bearing bristle-glands and with short simple hairs arising from leaf surface, ovate, obtuse, often cordate, persistent into mature canopy, 8–12 cm long, 70–120 mm wide; *petioles* 4–7 mm long. *Adult leaves* opposite or subopposite, strongly setose with bristle-glands bearing lateral simple hairs, discolorous, minutely papillose beneath, amphistomatic, broad-lanceolate to orbicular, apically rounded, basally rounded or cordate, 6–13 cm long, 25–100 mm wide; *petioles* 5–17 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 3–10 mm long; *pedicels* 13–25 mm long; intermediate internode single, 1–2 mm long; basal internode 3–5 mm long. *Mature buds* not seen. *Fruits* ovoid, 7–12 mm long, 6–9 mm diam. Fig. 111.

Flowering: Not recorded.

Distinguished by the combination: adult leaves broad, ovate to elliptical, usually setose; adult leaves markedly petiolate (petioles longer than in *C. dendromerinx*, shorter than in *C. disjuncta*); stocking regular, on trunk; smooth bark grey, not very powdery; epidermis and bristle-glands bearing simple hairs. New foliage is green in colour.

C. karelgica is scattered through drier southeastern parts of the central Kimberley region of Western Australia (Fig. 107). It occurs in open grassy savannah country on red clay-loams, at least some of which are derived from basalts. No overlap is apparent (in the specimens) with *C. confertiflora*, *C. dendromerinx* or *C. disjuncta*, though intergradation may occur in any contact zones that may be found.

The epithet is a reference to the main occurrence of this species between Karunjie and Elgee; the 'g' is to be pronounced soft as in 'gem'.

Conservation status: Although scattered and unfortunately neglected in our collecting, this species is more abundant than the number of collections suggests. Not considered to be at risk.

Selected specimen (from 3 examined): Western Australia: 2.5 miles [4 km] NW of Elgie [Elgee] Cliffs, *Lazarides 5088*, 17 Apr 1955 (CANB, DNA).

100. ACUIIF **Corymbia dendromerinx** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Confertiflorarum* combinatione characterum sequentium distinguitur: folia adulta lata, ovata ad elliptica, setosa, breviter petiolata; regio corticis persistentis non regularis, absens vel in parte basali truncis aliquando praesens; cortex laevis albus et pulviger; setoglandulae trichomata simplicia multa ferentes.

Type: Western Australia: 24.5 km SE of Tunnel Creek Cave, by road, *K. Hill 983, L. Johnson & D. Benson*, 1 Aug 1984 (holo NSW; iso CANB, DNA, PERTH).

Tree to 8 m. *Bark* smooth, white, powdery, shedding in thin scales, sometimes with an irregular, persistent tessellated grey stocking on the lower trunk. *Intermediate leaves* opposite, setose with trichomatiferous glands, ovate, obtuse, slightly cordate, persistent into mature canopy, 10–15 cm long, 50–90 mm wide; *petioles* 3–5 mm long. *Adult leaves* opposite or subopposite, setose with simple-hair-bearing bristle-glands, discolorous, minutely papillose beneath, amphistomatic, broad-lanceolate to orbicular, apically rounded, basally cordate or subcordate, 6–12 cm long, 25–70 mm wide; *petioles* 2–8 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 1–5 mm long; *pedicels* 7–12 mm long; intermediate internode single, 1–2 mm long; basal internode 1–4 mm long. *Mature buds* pyriform. *Fruits* ovoid, 8–9 mm long, 6–7 mm diam. Fig. 112.

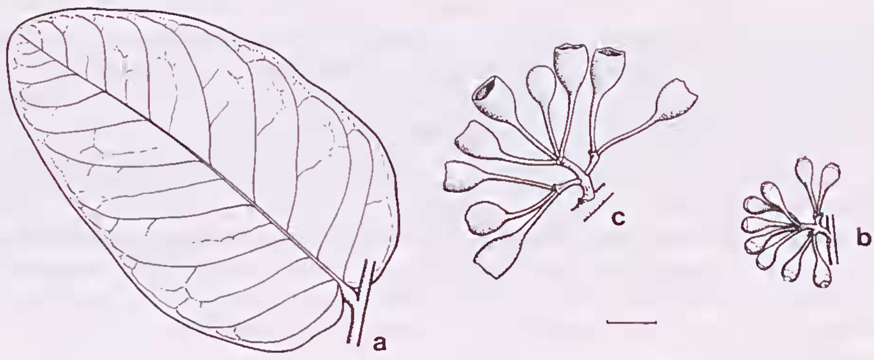

Fig. 112. C. *dendromerinx*. a, adult leaf. b, inflorescence and buds. c, inflorescence and fruits (a, c from *Wannan UNSW 20408*, b, from *Fitzgerald NSW 21499*). Scale bar = 1 cm.

Flowering: Oct.

Distinguished by the combination: adult leaves broad, ovate to elliptical, setose, shortly petiolate; stocking confined to lower trunk or almost absent; smooth bark white and powdery; bristle-glands bearing many simple hairs. New foliage is green in colour.

C. *dendromerinx* is abundant in the south-western Kimberley region of Western Australia, west of Fitzroy Crossing and south of the King Leopold Range extending into the eastern edges of the Dampier Peninsula, but not to Broome (Fig. 107). It also extends north onto islands to the west of the King Leopold Range. No overlap is apparent with C. *disjuncta*, but it may meet C. *karelgica* to the east. In the Broome district C. *paractia* (q.v.), a species of probable hybrid origin, replaces it, and occasional individual hybrids with C. *flavescens* are known where the species are sympatric (Appendix 1).

The epithet is from the Greek *dendron*, a tree, and *merinx*, a bristle, referring to the tree-like appearance, under magnification, of the bristle-glands bearing simple hairs.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Specimens examined: Western Australia: Cockatoo Island, *Bateman FRI 11351*, Aug 1953 (CANB); Koolan Island, *Wannan*, Jan 1974 (UNSW 20408, NSW); 22.6 km NW of Oobagooma homestead on Kimbolton road, *Hill 4112 & Stanberg*, 20 Sep 1991 (NSW, CANB, PERTH); 20 miles [32 km] SW of 'Oobagooma' station, *Lazarides 3125*, 22 June 1952 (CANB, NSW); Meda, May River, *Fitzgerald*, Apr 1905 (NSW 21499); between Pindan Bore and Millard Soak, 3.0 km N of highway 22.7 km E of Derby, *Hill 976, Johnson & Benson*, 31 July 1984 (NSW); 127.6 km ENE of Broome P.O. on Derby road, *Brooker 10120*, 19 Oct 1988 (CANB, NSW); NW end of Grant Range, *Hill 3448, Johnson & Stanberg*, 24 Nov 1988 (NSW, CANB, PERTH).

ACUK Series Gilbertenses

Bark persistent on part of trunk and regularly tessellated, smooth above or (in C. *inobvia* and C. *blakei*) with rough bark only at ground level. Leaves dull, oil glands present but obscured at least in intermediate and adult leaves. Bristle-glands present on juvenile and (except in C. *blakei* subsp. *rasilis*) intermediate leaves, laterally bearing short simple hairs except sometimes in C. *blakei*. Intermediate and adult leaves with all cells of the lower epidermis bulging so that the surface appears minutely papillose. Intermediate leaves broadly to narrowly oblong-ovate, often cordate. Adult leaves oblong-ovate to narrow-lanceolate or linear, petioles short. Inflorescences condensed, sometimes highly reduced (in *C. blakei*, especially subsp. *rasilis*), penultimate internodes (peduncles) from moderately to very short.

Four species, with a replacement pattern in Queensland from near Chillagoe south to near Thargomindah, mostly on very shallow soils over siliceous substrates, but *C. chillagoensis* at least at times on or near limestone outcrops (Fig. 114).

All four species can be regarded as constituting the single Superspecies *Gilbertensis*. The series may be part of a clade with *Confertiflorae* and *Asperae* and, if so, could be better in subseries rank.

Although close to Series *Confertiflorae* in the papillose leaf-epidermis, cordate juvenile leaves and inflorescences, the *Gilbertenses* may show some intergradation with (or introgression from) *C. tessellaris* (Series *Tessellares*) where the range of *C. blakei* subsp. *rasilis* is contiguous with that of *C. tessellaris*.

101. ACUKKA **Corymbia chillagoensis** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species affinitatis *C. gilbertensis* combinatione characterum sequentium distinguitur: cortex in parte basali trunci persistens; folia intermedia (sine dubio juvenilia) setoglandulas trichomatiferas ferentia; folia intermedia latolanceolata vel ovata; folia adulta angusta et ad bases attenuata.

Type: Queensland: 3.4 miles [5.4 km] W of Chillagoe, *M.I.H. Brooker 3372*, 26 Jan 1972 (holo NSW; iso CANB).

Tree to 12 m. *Bark* smooth, white, shedding in thin scales, with a persistent tessellated grey stocking from 0.5–1.5 m on lower trunk. *Intermediate leaves* opposite, setose with bristle-glands laterally bearing simple hairs, broad-lanceolate to ovate, obtuse or acute, basally rounded or slightly cordate, persistent into mature canopy, 6–12 cm long, 25–45 mm wide; *petioles* 2–4 mm long. *Adult leaves* opposite or subopposite, dull, discolorous, amphistomatic, lanceolate, acute or acuminate, 4–13 cm long, 7–25 mm wide; *petioles* 1–5 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* usually 7-flowered; *peduncles* 3–7 mm long; *pedicels* 7–16 mm long; intermediate internode single, 1–5 mm long; basal internode 2–5 mm long.

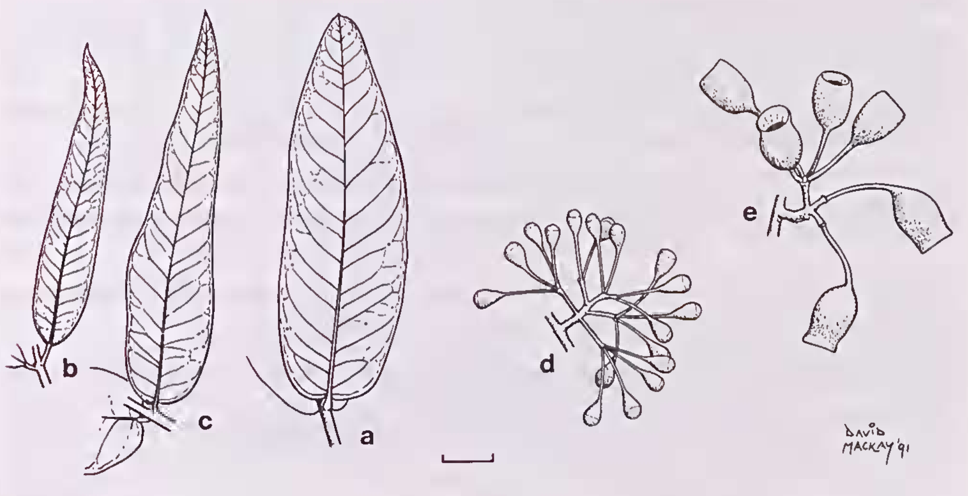

Fig. 113. *C. chillagoensis* a, intermediate leaf. b, c, adult leaf forms. d, inflorescence and buds. e, inflorescence and fruits (a, b, c, d from *Brooker 3372*, e from *Clarkson 4260*). Scale bar = 1 cm.

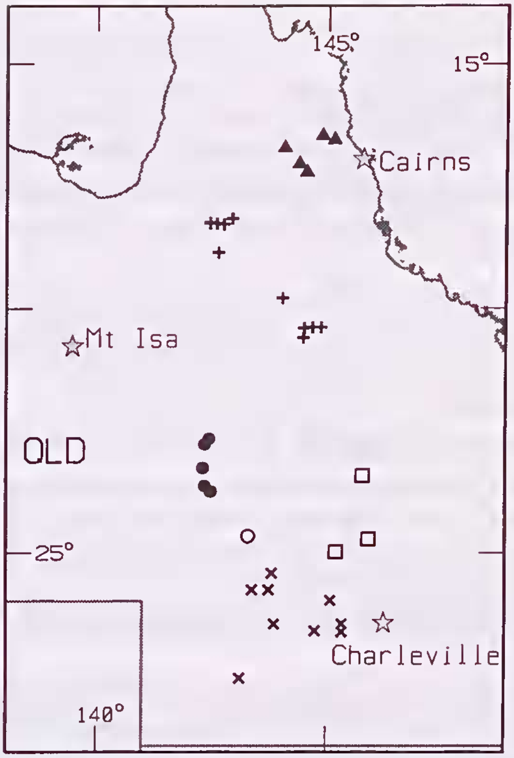

Fig. 114. Distribution of *C. chillagoensis* (triangle), *C. gilbertensis* (plus), *C. inobvia* (square), *C. blakei* subsp. *blakei* (solid circle), *C. blakei* subsp. *rasilis* (oblique cross), subsp. *blakei* – subsp. *rasilis* (open circle).

Mature buds pyriform, 5–6 mm long, 3–4 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 7–11 mm long, 5–9 mm diam. Fig. 113.

Flowering: Possibly erratic, recorded Jan, July.

Distinguished by the combination: bark persistent on lower trunk only; intermediate leaves broad-lanceolate to ovate, setose with bristle-glands bearing simple hairs; adult leaves narrow, basally tapered.

Sporadic and localised in distribution, known from a few places in north-eastern Queensland between 'Maitland Downs' and the Chillagoe district (Fig. 114).

C. chillagoensis occurs in hilly country, in local depressions in granite, sandstone or limestone areas. Near Chillagoe it occurs around limestone outcrops in situations protected from fire. A hybrid is known with *C. confertiflora* (Appendix 1).

The epithet refers to the main occurrence around the township of Chillagoe.

Conservation status: possibly rare, unlikely to be at risk. 2K.

Selected specimens (from 9 examined): Queensland: between Mt Carbine and 'Maitland Downs', *Hyland 8059*, 11 July 1975 (QRS, CANB, NSW); 22.4 miles [35.8 km] NW of Mt Carbine on road to Palmer River, *Brooker 4013*, 8 Aug 1973 (CANB, NSW); 7 km E of Elizabeth Creek on road to Chillagoe, *Clarkson 4260*, 14 Jan 1982 (BRI, CANB, DNA, NSW, QRS, PERTH); few miles from Chillagoe on Mungana road, *Hyland 5831*, 26 Jan 1972 (QRS, CANB, NSW); Walsh River, *Hyland 8059*, 20 Feb 1975 (QRS, NSW); 6.4 km E of Chillagoe, *Hill 4678 & Stanberg*, 5 July 1994 (NSW, BRI, DNA).

102. ACUKKG **Corymbia gilbertensis** *(Maiden & Blakely) K.D. Hill & L.A.S. Johnson,* **comb. nov.**

Basionym: *Eucalyptus clavigera* Cunn. ex Schauer var. *gilbertensis* Maiden & Blakely in Maiden, Crit. Rev. Eucalyptus 7: 432, plate 283, fig. 8, 1928.

Type citation: 'Ridges, Gilbert River, North Queensland (C.T. White, February, 1922).' Maiden and Blakely then specified this collection as 'Type' in the legend to plate 283 (p. 450).

Type: Queensland: Gilbert River, *C.T. White 1392*, 11 Feb 1922 (holo NSW; iso BRI, MEL).

≡ *E. gilbertensis* (Maiden & Blakely) S.T. Blake, Austral. J. Bot. 1: 220 (1953).

Tree to 12 m. *Bark* smooth, white, grey or salmon, shedding in thin scales, sometimes with a grey tessellated stocking on lower trunk. *Intermediate (or late juvenile) leaves* opposite, ovate, obtuse, 7–10 cm long, 30–50 mm wide; setose with bristle-glands laterally bearing short simple hairs; *petioles* 2–5 mm long. *Adult leaves* disjunct, dull, amphistomatic and concolorous, bristle-free and hairless, linear to narrow-lanceolate to broad-lanceolate, acute or acuminate, 4–13 cm long, 4–20 mm wide; *petioles* 4–11 mm long; *oil glands* obscured. *Inflorescences* ± condensed; *umbellasters* to 7-flowered; *peduncles* 0–5 mm long; *pedicels* 2–11 mm long; intermediate internodes 0–1 mm long; basal internode 1–4 mm long. *Mature buds* pyriform; 5–7 mm long, 4–5 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 6–10 mm long, 5–8 mm diam. Fig. 101.

Flowering: Oct (seasonally dependent, not regularly annually).

Distinguished by the ovate, persistently setose juvenile or early intermediate leaf-stages, the bristle-glands bearing simple hairs. The inflorescences are more condensed, and with fewer flowers overall, than in *C. chillagoensis* but less reduced than in *C. inobvia* and *C. blakei*. Populations in the north of the range are usually neotenous, whereas those in the south develop canopies of fully adult leaves more readily. Adult leaves in the southern populations are also usually smaller and narrower, but the two extremes are clinally linked.

Central north-western Queensland, sporadic, from west of Croydon to near Einasleigh, and south to the Gregory Range and Porcupine Gorge district (Fig. 114).

C. gilbertensis is locally frequent in woodland on well-drained sites on shallow soils, often with thickets of lancewood (*Acacia shirleyi*) around Tertiary lateritic residuals in the west of the range, in eucalypt woodlands on shallow sandy soils in the east, and on skeletal soils around sandstone outcrops in the south. Probable hybrids with *C. confertiflora* and *C. dallachiana* are recorded (Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 15 examined): Queensland: 8 miles [13 km] W of Croydon, *Johnson & Pryor*, 20 Oct 1964 (NSW 301790); 60.3 km from Croydon towards Georgetown, *Hill 3581 & Stanberg*, 4 Dec 1988 (NSW); Esmeralda, about SSE of Croydon, *Blake 19622*, 18 July 1954 (BRI, NSW); 'Chudleigh Park' Station, southern Gregory Range, on the upper Stawell River, *Hill 3734 & Stanberg*, 29 July 1990 (NSW, BRI, CANB); White Mountains, scree slope, *Godwin* , Aug 1984 (NSW 207882); Porcupine Gorge lookout, *Hill 3723 & Stanberg*, 28 July 1990 (NSW, BRI, CANB); 45.3 km N of Hughenden on The Lynd road, *Hilt 3721 & Stanberg*, 28 July 1990 (NSW, BRI, CANB).

103. ACUKKI **Corymbia inobvia** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species affinitatis *C. gilbertensis* combinatione characterum sequentium distinguitur: folia adulta angusta (linearia ad anguste lanceolata); folia intermedia plusminusve persistentia, ovata, setoglandulas nonnullas trichomatiferas ferentia; pedicelli breves, internodia inflorescentiae elongata.

Type: Queensland: Red Mountain, 20.6 km from Jericho-Barcaldine road on turnoff from near Lochnagar, *K.D. Hill 3875 & L.A.S. Johnson*, 23 May 1991 (holo NSW; iso BRI, CANB).

Tree to 10 m. *Bark* smooth, white, shedding in thin scales, with an irregular tessellated stocking on the lower trunk of larger individuals. *Intermediate leaves* opposite to disjunct, setose with bristle-glands laterally bearing some short simple hairs, broad-lanceolate to ovate, obtuse or rounded and minutely apiculate, to 8 cm long, to 30 mm wide; *petioles* 3–5 mm long. *Adult leaves* disjunct, dull, amphistomatic and concolorous, bristle-free and glabrous, linear to lanceolate, acuminate, 4–10 cm long, 4–11 mm wide; *petioles* 3–9 mm long; *oil glands* obscured or ± discernible in strong transmitted light. *Inflorescences* partly condensed; *umbellasters* 3–7-flowered; *peduncles* 0–2 mm long; *pedicels* 2–4 mm long; intermediate internodes one or two, 1–3 mm long; basal internode 4–7 mm long. *Mature buds* not seen. *Fruits* ovoid to cup-shaped, 6–8 mm long, 6–8 mm diam. Fig. 115.

Flowering: Not recorded.

Distinguished by the combination: narrow (linear to narrow-lanceolate) adult leaves; somewhat persistent ovate intermediate leaves, which are setose with bristle-glands bearing simple hairs; short pedicels; distinct, although short, intermediate internodes in the inflorescence.

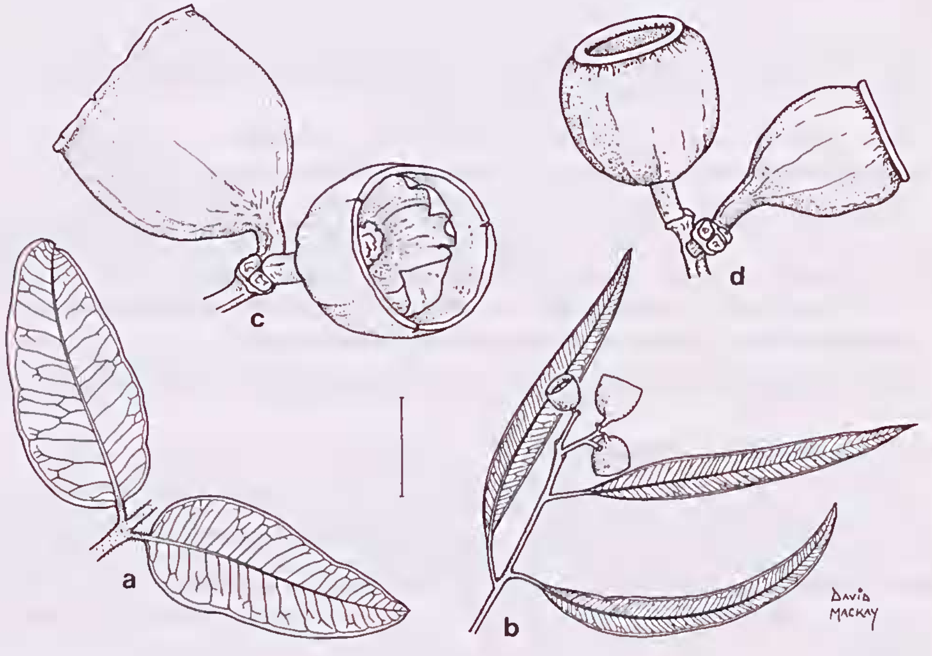

Fig. 115. *C. inobvia* a, intermediate leaf. b, adult leaf, inflorescence and fruits. c, d, fruits (a from *Hill 3876 & Johnson*, b, d from *Hill 3875 & Johnson*, c from *Everist 1995*). Scale bar: a, b = 2 cm; c, d = 4 mm.

C. *inobvia* is known only from a few stands scattered sporadically through central-western Queensland (fig. 114), all apparently on skeletal soil on massive laterite residuals. The stand at Red Mountain occurs around the edges of laterite cliffs and on the upper scree slopes below the cliffs, with Eastern Lancewood (*Acacia* sp. aff. *shirleyi*) and *Eucalyptus* (*Symphyomyrtus*) *exserta*. *C. aparrerinja* is present in the general vicinity on deeper, reddish sandy soils.

Conservation status: 3R-. Although restricted to a very specific and uncommon habitat, occurrences of this habitat type are remote and unlikely to be under immediate threat.

The epithet is from the Latin *inobvius*, out-of-the-way, from the remote occurrences.

Specimens examined: Queensland: Red Mountain, 20.6 km from Jericho to Barcaldine road on turnoff from near Lochnagar, *Hill 3876, 3877 & Johnson*, 23 May 1991 (NSW, BRI, CANB); Romulus Tableland, 50 km SE of Blackall, *Beeston 1103* C, July 1975 (BRI); Lorne Peak, c. 50 miles [80 km] SSW of Blackall, *Everist 1995*, 15 Feb 1940 (BRI).

104. ACUKKO **Corymbia blakei** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species affinitatis *C. gilbertensis* combinatione characterum sequentium distinguitur: cortex plus minusve albidus; folia adulta angusta, haud nitentia; pedunculi pedicellique et internodia inflorescentiae valde reducta.

Type: Queensland: Tranby, *S.T. Blake 11444*, 9 May 1936 (holo NSW; iso BRI, CANB).

Tree to 10 m. *Bark* smooth, ± white, shedding in thin scales, sometimes with a short tessellated stocking on the lower trunk of larger individuals. *Intermediate leaves* opposite, bristle-free to setose with bristle-glands bearing (or sometimes lacking) simple hairs, lanceolate or narrow-oblong to ovate, acute to obtuse or rounded and apiculate, to 9 cm long, to 35 mm wide; *petioles* 3–5 mm long. *Adult leaves* disjunct, dull, amphistomatic and concolorous, linear to lanceolate, acuminate, 4–13 cm long, 4–15 mm wide; *petioles* 3–17 mm long; *oil glands* obscured. *Inflorescences* ± condensed and considerably reduced; *umbellasters* 3–7-flowered; *peduncles* 0–2 mm long; *pedicels* 1–4 mm long; intermediate internodes 0–3 mm long; basal internode 1–4 mm long. *Mature buds* broadly pyriform, 5 mm long, 3 mm diam., *calyptra* c. 1/3 as long as hypanthium, hemispherical. *Fruits* ovoid to cup-shaped, 6–10 mm long, 6–9 mm diam. Fig. 116.

Distinguished by the combination: bark smooth and ± white; adult leaves narrow, dull; peduncles, pedicels and inflorescence internodes highly reduced. Larger trees and possibly young saplings sometimes develop a distinctly demarcated tessellated stocking, although this species is often a small, stunted tree (frequently several-stemmed) and as such most commonly lacks a developed stocking. However, some regularly tessellated bark is usually to be found at ground level, unlike the condition in such species as *C. aparrerinja* and others of series *Grandifoliae*.

A rare and localised species occurring in association with exposed Tertiary duricrust silcrete surfaces. Individuals in most occurrences examined show evidence of great age and repeated coppice regrowth under the harsh conditions. The species has a sporadic range in western Queensland from south of Winton to south-west of Quilpie (Fig. 114).

C. blakei has been erroneously referred to *E. gilbertensis* by Chippendale (1988), and to *E. papuana* by Blake (1938) and other Queensland botanists.

Intergradation probably occurs with *C. tessellaris* in intermediate habitats in country east of Quilpie (Appendix 1).

The epithet commemorates Dr Stanley Thatcher Blake (1911–1973), formerly Senior Botanist with the Queensland Herbarium, who contributed significantly to the understanding of the bloodwoods generally, and who collected the type specimen. A habit photograph was provided by Blake (1938), who included the species in the then current catch-all concept of '*Eucalyptus papuana*'.

Two geographic subspecies can be recognised.

1 Juvenile or intermediate leaves ovate, persisting setose ..... 104A. subsp. **blakei**

1* Juvenile or intermediate leaves lanceolate to narrow-oblong, non-setose except in very early stages .... 104B. subsp. **rasilis**

104A. ACUKKOB **Corymbia blakei** *K.D. Hill & L.A.S. Johnson* subsp. **blakei**

Tree to 8 m. Bark smooth, white and grey, powdery, with some tessellated bark at ground level. Intermediate leaves ovate, setose with ± trichomatiferous bristle-glands, to 6 cm long, to 30 mm wide; petioles to 5 mm long. Adult leaves narrow-lanceolate to lanceolate, dull, 4–9 cm long, 6–15 mm wide; petioles 3–10 mm long. Peduncles 0–2 mm long; pedicels 1–3 mm long; intermediate internode single, 0–2 mm long; basal internode 1–4 mm long. Fruits 6–10 mm long, 6–7 mm diam. Fig. 116.

Flowering: Not recorded.

Distinguished by the ovate, setose juvenile or intermediate leaves with bristle-glands some of which bear a few simple hairs.

Rare and localised, south of Winton (fig. 114). Apparently restricted to exposed flat silcrete duricrust over sandstone that has been scoured free of topsoil but left intact (not found on breakaway edges to this country).

Conservation status: 2(?3)R-. Although restricted to a very specific and uncommon habitat, occurrences of this habitat are remote and unlikely to be under immediate threat.

Selected specimens (from 6 examined): Queensland: 8.6 km from Cork Mail Run road on Red Hill Road (22°47'S 142°19'E), *Hill 3861, 3862, 3863 & Johnson*, 23 May 1991 (NSW, BRI, CANB); 85.1 km from Westerton road junction on Winton road, just N of Mayne River, *Hill 3855, 3856 & Johnson*, 22 May 1991 (NSW, BRI, CANB).

Intergrade between the subspecies: Subsp. *blakei* – subsp. *rasilis*

Queensland: 30.8 km NE of Jundah on Longreach road, *Hill 3848 & Johnson*, 22 May 1991 (NSW, BRI, CANB).

A hybrid of this intergrade is known with *C. aparrerinja* (Appendix 1).

104B. ACUKKOR **Corymbia blakei** *K.D. Hill & L.A.S. Johnson* subsp. **rasilis** *K.D. Hill & L.A.S. Johnson*, subsp. nov.

Ab subspecie *blakei* foliis juvenilibus intermediisque angustioribus (lanceolatis ad anguste oblongis) post stadios praecoces sine setoglandulis differt.

Type: Queensland: 104.0 km W of Charleville on Quilpie road, 1.1 km E of Paroo River, *K.D. Hill 3835 & L.A.S. Johnson*, 21 May 1991 (holo NSW; iso BRI, CANB, DNA, MEL).

Tree to 10 m. Bark smooth, white and grey, powdery, sometimes with a grey tessellated stocking on the lower trunk of larger individuals. Juvenile or intermediate leaves lanceolate to narrow-oblong, setose with bristle-glands (not bearing trichomes unless at stages earlier than those seen) in very early stages only, to 7 cm long, to 15 mm wide; petioles to 3 mm long. Adult leaves narrow-lanceolate to

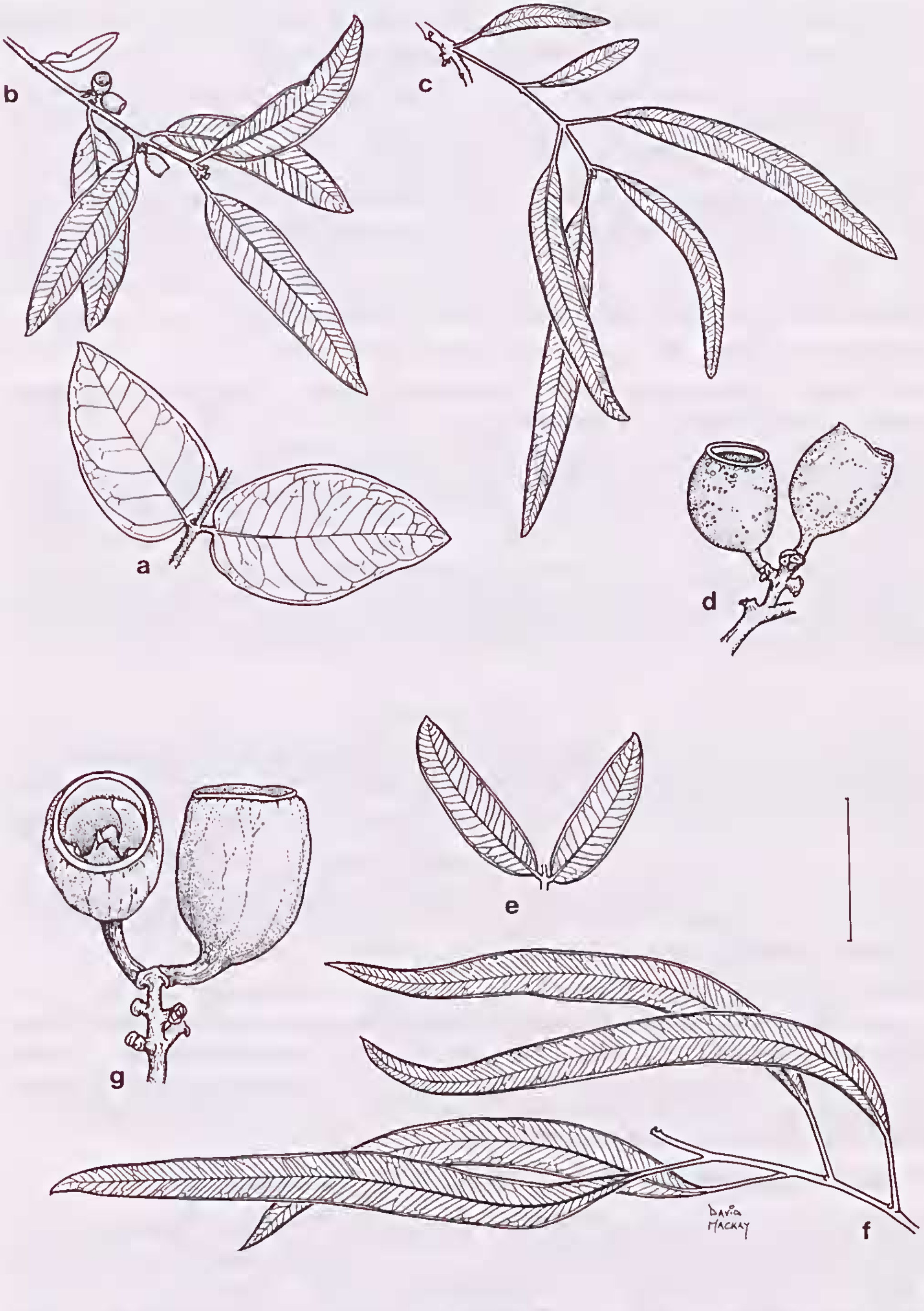

Fig. 116. *C. blakei* subsp. *blakei*. a, juvenile or early intermediate leaf. b, adult leaves and fruits. c, adult leaves. d, inflorescence and fruits (a, b from *Blake 11444*, c, d from *Hill 3861 & Johnson*). *C. blakei* subsp. *rasilis*. e, juvenile or early intermediate leaf. f, adult leaf. g, inflorescence and fruits (all from *Hill 3838A & Johnson*). Scale bar: a, b, c, e, g = 3 cm; d, f = 1 cm.

lanceolate, dull, 5–13 cm long, 5–14 mm wide; petioles 7–17 mm long. Peduncles 0–2 mm long; pedicels 1–3 mm long; intermediate internode single, 0–2 mm long; basal internode 2–5 mm long. Fruits 6–10 mm long, 7–9 mm diam. Fig. 116.

Flowering: Not recorded.

Distinguished by the relatively narrow (lanceolate to narrow-oblong) intermediate or late juvenile leaves that are bristle-free from early stages.

Restricted to shallow soils on silcrete hardpans or stony slopes in the Cheviot Range and Grey Range east and south-west of Quilpie in far-western Queensland (Fig. 114). Very locally abundant in *Acacia* shrublands.

Although this subspecies has the general appearance, habit and habitat of subsp. *blakei*, its inflorescences and intermediate or late juvenile leaves in particular suggest that it may have had some introgressive genetic connection with *C. tessellaris* in the past. Subsp. *blakei* shows greater resemblance in this stage to *C. gilbertensis* and *C. inobvia*, which we would regard as the sister taxa to *C. blakei*.

Conservation status: 3R-. See comments above under subsp. *blakei*.

The epithet is from the Latin *rasilis*, scraped or smooth, in reference to the mostly smooth juvenile and intermediate leaves.

Selected specimens (from 16 examined): Queensland: summit plateau of Cheviot Range, *P. Wilson 367 & Pickering*, 19 Sep 1989 (NSW); 155.8 km from Quilpie on Windorah road, *Hill 3842 & Johnson*, 21 May 1991 (NSW, BRI, CANB); 61 miles [98 km] W of Adavale, *Everist 1526*, 25 June 1937 (BRI); 2 km W of Range Tank (25°59'S 145°03'E), *Neldner & Thomas 759*, 15 May 1982 (BRI); 58.9 km from Quilpie on Thylungra road, *Hill 3839 & Johnson*, 21 May 1991 (NSW, BRI, CANB); 104.0 km W of Charleville on Quilpie road, 1.1 km E of Paroo River, *Hill 3836 & Johnson*, 21 May 1991 (NSW); 106 km from Charleville towards Quilpie, *Bean 438*, 15 May 1986 (NSW); Rocky Gidgee Creek, near Wilson River, *MacGillivray 978*, 4 Sep 1923 (BRI).

ACUL Series Asperae

Bark usually mainly smooth, but some regularly tessellated bark present at least on young individuals and/or at the extreme base (ground level) (in contrast to Series *Grandiflorae*). Adult leaves often neotenous but not so in all taxa. Intermediate and neotenous adult leaves with the epidermal cells of the lower surface each bulging to render the surface minutely papillose. Bristle-glands not bearing simple hairs. Inflorescences at flowering often, but not always, on leafless portions of branchlets, usually highly condensed with all internodes reduced (Fig. 117), but basal internode sometimes less reduced.

This series is confined to low-rainfall regions (Fig. 93), extending well into desert country. Maximum diversity is attained in the Pilbara region of Western Australia and in desert country to the east at the same latitudes. Two of the species, *C. aspera* and *C. punkapitiensis*, constituting a pair of vicariants, can be grouped as Superspecies *Aspera* (Appendix 3). The series may be part of a clade with *Confertiflorae* and *Gilbertenses* and, if so, could be better in subseries rank.

105. ACULLC **Corymbia candida** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Species *C. asperae* affinis sed combinatione characterum sequentium distinguitur: folia adulta intermediaque acuta acuminatave, adulta frequenter angustiora crassioraque et minus setosa; cortex candidus pulvigerque. A *C. ferriticola* petiolis brevioribus, fructibus plerumque majoribus et cortice plerumque candidiore differt.

Type: Western Australia: 15.4 km N of Giralia turnoff on coastal highway, *K. Hill 420, L. Johnson, D. Blaxell, I. Brooker & W. Edgecombe*, 29 Oct 1983 (holo NSW; iso AD, CANB, PERTH).

Tree to 20 m, often less than 10 m or shrubby. *Bark* smooth, white, thickly powdery, shedding in thin scales, frequently with some tessellated bark at the base of the trunk, especially on young trees. *Intermediate leaves* opposite, ovate, acute, setose with bristle-glands not bearing simple hairs, 3–11 cm long, 20–70 mm wide; *petioles* 0–3 mm long. Intermediate leaves usually persisting in the canopy, smaller and narrower at later stages. *Adult leaves* opposite or slightly disjunct, dull or slightly glossy, weakly discolorous, amphistomatic, lanceolate to ovate, acute or acuminate, bristle-free or setose with non-trichomatiferous bristle-glands, 3–11 cm long, 8–30 mm wide; *petioles* 1–8 mm long; *oil glands* sparse or obscured. *Inflorescences* condensed; *umbellasters* 3–7-flowered; *peduncles* 0–1 mm long; *pedicels* 1–9 mm long; intermediate internodes 0–2 mm long; basal internode 2–7 mm long. *Mature buds* pyriform, 3–4 mm long, 2–3 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* ovoid, 7–12 mm long, 6–13 mm diam. Fig. 118.

Flowering: Not recorded.

The epithet is from the Latin *candidus*, glossy white, referring to the clean white bark of the trunk.

C. candida differs from *C. aspera*, with which it has been persistently confused (see Appendix 4), in the acute or acuminate, narrower, thicker and usually less setose adult and intermediate leaves, and the thickly powdery white bark. The related *C. ferriticola* may be distinguished by its longer petioles on the duller adult and juvenile leaves, the generally smaller fruits, and the bark, which is frequently (though not at all times) grey or pink.

Cases (e.g. *Hill 437 et al.)* occur of inflorescence 'flexibility' (Briggs & Johnson 1979); in these, in place of axillary inflorescences with short basal internodes, some axillary shoots may have an elongated basal internode with more or less developed foliage leaves at the first node, the axis continuing and terminating as a normal metabotryoid.

This species is known inland in Western Australia from the north of the Great Sandy Desert to Exmouth Gulf and into the Pilbara region, north and northeast of Meekatharra, and through the Gibson Desert into the Tanami Desert in the west of the Northern Territory (Fig. 119). Unlike the other species in Series *Asperae*, *C. candida* occurs consistently on sandy or sandy-loam soils in non-rocky sites.

Three geographic subspecies can be recognised.

1 Leaves mostly not cordate or setose in flowering stages

2 Leaves dull in flowering stages, usually small (mostly <6 cm long) .... 105A. subsp. **candida**

2* Leaves ± glossy in flowering stages, usually large (largest >7 cm long) .... 105B. subsp. **lautifolia**

1* Leaves mostly cordate and distinctly setose in flowering stages .... 105C. subsp. **dipsodes**

105A. ACULLCA **Corymbia candida** *K.D. Hill & L.A.S. Johnson* subsp. **candida**

Tree to 15 m, often much less and sometimes shrubby. *Intermediate leaves* 7–12 cm long, 50–70 mm wide. *Adult leaves* (± neotenous) usually opposite, sometimes slightly disjunct, dull or slightly glossy, weakly discolorous, amphistomatic, lanceolate to broad-lanceolate, acute or acuminate, bristle-free or sparsely setose with bristle-glands, 3–8 cm long, 8–25 mm wide; *petioles* 1–4 mm long. *Mature buds* pyriform, 3–4 mm long, 2–3 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* ovoid, 8–12 mm long, 6–10 mm diam. Fig. 118.

Distinguished from the other subspecies by the small, dull (though green, not grey-green), usually bristle-free (though more or less neotenous) adult leaves. The inflorescences also tend to be less reduced than in the other subspecies.

Subsp. *candida* occurs inland from Exmouth Gulf, on the plains country to the west of the Pilbara region (Fig. 119), often in open gallery woodlands on red-soil plains bordering watercourses, although scattered trees occur on more or less level red-earth country away from watercourses in some areas.

Conservation status: Not considered to be at risk.

Selected specimens (from 16 examined): Western Australia: Yanrey station, *Mitchell 501*, 8 Nov 1977 (PERTH, NSW); 43 km from coastal highway on Yanrey road, *Hill 421, Johnson, Blaxell, Brooker & Edgecombe*, 29 Oct 1983 (NSW); 35 km from coastal highway on Onslow road, *Hill 428, Johnson, Blaxell, Brooker & Edgecombe*, 29 Oct 1983 (NSW); 6 km from Ashburton River towards Carnarvon on coastal highway, *Telford 6599*, 8 Aug 1977 (CBG, NSW, PERTH); near Uaroo Stn, *Brooker 8312*, 19 Oct 1983 (CANB, NSW); 3.0 km SE of Barradale on Lyndon road, *Johnson 9343 & B. Briggs*, 2 Aug 1991 (NSW, CANB, DNA, PERTH); 21.8 km ENE of Coastal Hwy at Nanutarra towards Paraburdoo, *Brooker 10738*, 17 Apr 1991 (CANB, NSW).

Intergrades between the subspecies: Subsp. *candida* – subsp. *lautifolia*.

Populations in the north-central Pilbara region, in the valley of the Fortescue River near Wittenoom (Fig. 119), are morphologically intermediate between these two subspecies.

Selected specimen (from 3 examined): Western Australia: 36 km W of Wittenoom on track to Millstream, *Hill 437, Johnson, Blaxell, Brooker & Edgecombe*, 30 Oct 1983 (NSW).

105B. ACULLCL **Corymbia candida** *K.D. Hill & L.A.S. Johnson* subsp. **lautifolia** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Inter subspecies *C. candidae* foliis adultis majoribus, plusminusve nitentibus flavovirentibus plerumque laevibus et fructibus plerumque aliquanto majoribus distinguitur.

Type: Western Australia: Highway 1, 2.5 km SW of junction with Highway 95, *L.A.S. Johnson 9294 & B.G. Briggs*, 26 July 1991 (holo NSW; iso CANB, PERTH).

Tree to 15 m (but often much less). *Intermediate leaves* 5–10 cm long, 50–70 mm wide. *Adult leaves* opposite to slightly disjunct, usually distinctly semi-glossy and slightly yellowish, weakly discolorous, amphistomatic, broad-lanceolate or broader, acute or acuminate, bristle-free, 5–11 cm long, 13–30 mm wide; *petioles* 2–8 mm long. *Mature buds* pyriform, 3–5 mm long, 2–3 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* ovoid, 10–13 mm long, 9–12 mm diam. Fig. 118.

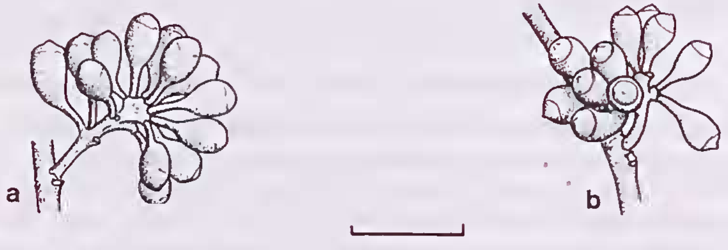

Fig. 117. Inflorescences of series *Asperae*. a, *C. aspera* (from *Dunlop 5569*). b, *C. ferriticola* (from *Hill 438 et al.*). Scale bar = 1 cm.

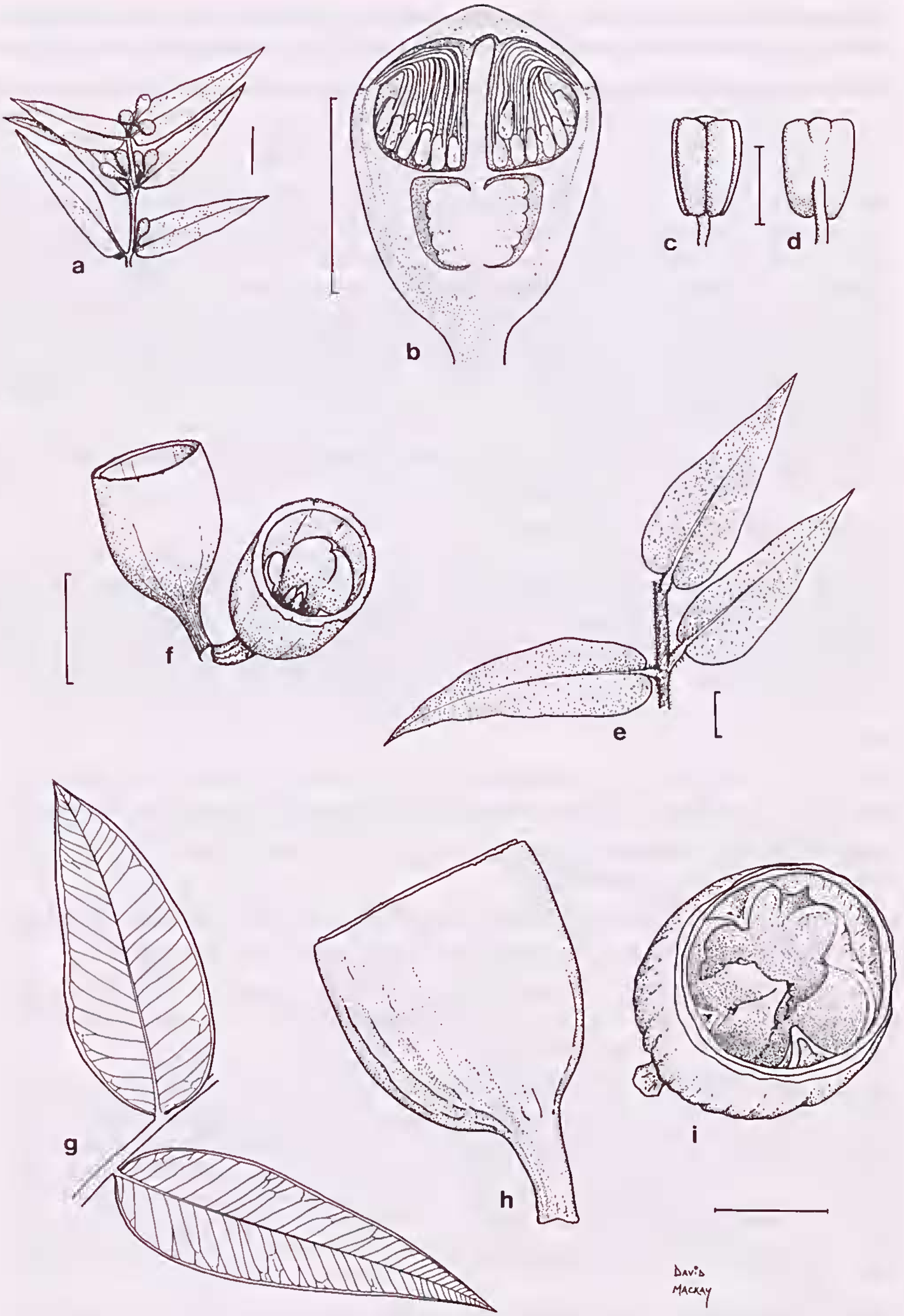

Fig. 118. *C. candida.* Subsp. *candida.* a, adult leaves, buds and inflorescences. b, median section of bud. c, d anther. Subsp. *dipsodes.* e, intermediate leaves. f, fruits. Subsp. *lautifolia.* g, adult leaves. h, i, fruit (a, b, c, d from *Mitchell 501*; e, f from *Johnson 2138*; g, h, i from *Johnson 9277 & Briggs*). Scale bars: g = 2.5 cm; a, e, f = 1 cm; h, i = 5 mm; b = 3 mm; c, d = 0.3 mm.

Distinguished from the other subspecies by the less neotenous, large, semi-glossy, yellowish-green, usually bristle-free adult leaves. The fruits are also generally larger.

Subspecies *lautifolia* usually occurs in very open woodlands on red-soil plains, often with no other eucalypt species. It is restricted to an area from Port Hedland eastwards across the northern edge of the Pilbara region (Fig. 119).

C. flavescens (series *Grandifoliae*) occurs in the same general area but slightly to the north. Although both taxa have more or less glossy, yellowish adult leaves, those of *C. flavescens* are distinctly petiolate, and *C. flavescens* does not share the small amount of persistent bark seen in the *C. candida* group. The similar leaves suggest that subsp. *lautifolia* may have arisen as a result of hybridisation between *C. candida* and *C. flavescens*, with subsequent introgression into the former. If so, the populations of subsp. *lautifolia* appear to be stabilised and persistent. Subsp. *lautifolia* also has fine and regular tertiary leaf venation similar to that of subsp. *candida* and *C. aspera*, whereas *C. flavescens* has irregular and more open tertiary venation as in *C. grandifolia* and series *Grandifoliae* in general.

The epithet is from the Latin *lautus*, washed or brilliant, and *folium*, a leaf, referring to the somewhat glossy adult leaves.

Conservation status: Not considered to be at risk.

Selected specimens (from 9 examined): Western Australia: 8.4 km ESE of Port Hedland on Highway 1, *Johnson 9277, 9278 & B. Briggs*, 26 July 1991 (NSW, CANB); c. 1.5 km S of Pippingarra homestead, c. 0.5 km W of main Port Hedland to Wittenoom road, c. 8.5 km S of main Port Hedland to Marble Bar road, *Barker 2032*, 22 Aug 1977 (AD, NSW); Mt Newman railway, *Paton 99*, Dec 1972 (DNA); 56 km from Port Hedland towards Whim Creek, *Brooker 10749, 10750*, 19 Apr 1991 (CANB, AD, NSW, PERTH); Warrawagine, *Beard 4614*, 16 Apr 1967 (PERTH, NSW); power line track from Tom Price railway towards Mt Brockman, *Brooker 10095, 10096*, 13 Oct 1988 (CANB, NSW).

Hybrids (or members of an intergrading hybrid swarm) between this subspecies and *C. ferriticola* subsp. *ferriticola* occur north of the Hamersley Range (see Appendix 1).

105C. ACULLCS **Corymbia candida** *K.D. Hill & L.A.S. Johnson* subsp. **dipsodes** *K.D. Hill & L.A.S. Johnson*, **subsp. nov.**

Inter subspecies *C. candidae* foliis adultis (valide neotenicis) non nitentibus, frequenter ovatis et plerumque setosis, fructibus plusminusve minoribus, distinguitur.

Type: Western Australia: 84.0 km S of Kumarina roadhouse on Great Northern Highway, *K.D. Hill 503, L.A.S. Johnson, D.F. Blaxell & M.I.H. Brooker*, 2 Nov 1983 (holo NSW; iso CANB, PERTH).

Tree to 15 m (rarely to 20 m). *Intermediate leaves* 5–11 cm long, 30–70 mm wide. *Adult leaves* (strongly neotenous) usually opposite, dull or slightly glossy, weakly discolorous, amphistomatic, broad-lanceolate to ovate, acute or obtuse, usually setose with bristle-glands not bearing simple hairs, 2.5–8 cm long, 15–30 mm wide; (on older trees some truly adult and bristle-free leaves sometimes present, as on *Johnson 2138*); *petioles* 0–1 mm long. *Mature buds* pyriform, 3–4 mm long, 2–3 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* ovoid, 7–11 mm long, 6–8 mm diam. Fig. 118.

Distinguished from the other subspecies by the dull green (but not grey-green), often ovate and usually setose adult leaves. Fruits also tend to be smaller.

Subsp. *dipsodes* usually occurs in very open woodlands on red-soil plains, frequently with *Acacia aneura* or other 'mulga' species, and often with no other eucalypt species. It is widespread, ranging across an area south from the north of the Great

Sandy Desert to the eastern Pilbara region and north and north-east of Meekatharra, and east across the Gibson and Tanami Deserts into the Northern Territory (Fig. 119).

Hybrids with *C. aparrerinja* occur occasionally where the two taxa occur in proximity (Appendix 1).

The epithet is from the Greek, *dipsodes*, thirsty, from the dry habitat of this subspecies.

Conservation status: Locally frequent over a wide area, not considered to be at risk.

Selected specimens (from 35 examined): Western Australia: Mt Bannerman, *Done 3886 & Dunlop*, 9 Mar 1981 (DNA); Ankatell [Anketell] Ridge, Great Sandy Desert, *Mitchell 1207*, 14 May 1979 (DNA); 0.4 km S of Carrowina Creek, *P. Wilson 955 & Rowe*, Sep 1991 (NSW, CANB, PERTH); Well 31, Canning Stock Route [22°32' S, 124°24' E], *Chambers CA/286*, 21 Aug 1993 (NSW); 68.7 km W of Newman on track to Tom Price via Mt Meharry, *Hill 489, Johnson, Blaxell, Brooker & Edgecombe*, 1 Nov 1983 (NSW); 40 km E of Newman to Nullagine road on Jiggalong road, *Pryor*, 20 Aug 1985 (NSW); near Ophthalmia dam, Newman, *Brooker 8193*, 4 July 1983 (CANB, NSW); Capricornia roadhouse, 10 km S of Newman on Gt [Great] Northern Highway, *Hill 497, Johnson, Blaxell & Brooker*, 2 Nov 1983 (NSW); Mundiwindi, *B. Briggs 3595a*, 14 June 1970 (NSW); 151.4 km NW of Wiluna towards the Great Northern Highway, *Brooker 10726*, 15 Apr 1991 (CANB, DNA, NSW, PERTH); Doolgunna, 0.5 km S of homestead, *Johnson 2138*, 30 Aug 1967 (NSW); between Meekatharra and Wiluna, on road, *Mitchell*, 1983 (NSW 314764).

Northern Territory: 16.9 miles [27.1 km] N of Tanami, *Chippendale*, 10 Apr 1959 (DNA, NSW); 10 miles [16.0 km] ESE of deserted Tanami township, *Lazarides 6252*, 22 Apr 1957 (CANB, NSW); 30 km S of Rabbit Flat turnoff on Tanami Track, *Keith 125 & Pellow*, 2 June 1986 (SYD, NSW); 19 km NW of Lake Surprise, *Latz 10942*, 20 Oct 1988 (DNA); 9.5 miles [15.2 km] NW The Granites, *Chippendale NT 4219*, 2 May 1958 (DNA, NSW); 39 miles NE of Lake Mackay, *Chippendale NT 3375*, 15 June 1957 (DNA); 8.4 km E of WA border on Kintore road, plot 1182, *Leach 1960*, 27 Apr 1988 (DNA); c. 13 km NE of Winneke [Winnecke] Hills, *Kalotas 2137*, 28 Sep 1986 (DNA).

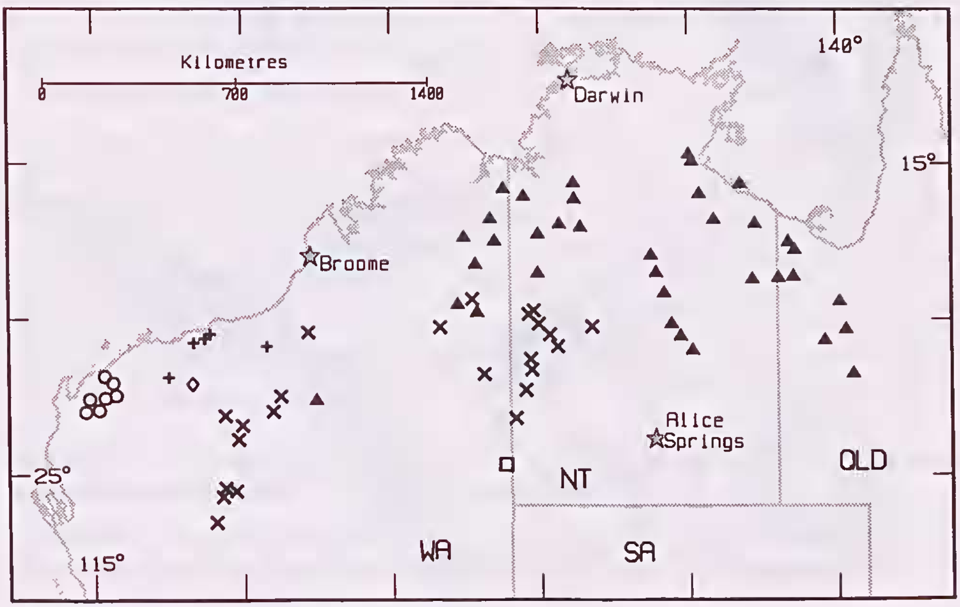

Fig. 119. Distribution of C. *candida* subsp. *candida* (circle), C. *candida* subsp. *lautifolia* (plus), C. *candida* subsp. *dipsodes* (oblique cross), C. *candida* subsp. *dipsodes* – C. *ferriticola* subsp. *ferriticola* intergrade (diamond), C. *aspera* (triangle), C. *punkapitiensis* (square).

106. ACULLF **Corymbia ferriticola** *(Brooker & Edgecombe) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus ferriticola* Brooker & Edgecombe, Nuytsia 5(3): 373 (1986).

Type: Western Australia: Wittenoom Gorge (22°17'S, 118°19'E), *M.I.H Brooker 8314 & W.B. Edgecombe*, 30 Oct 1983 (holo: PERTH; iso: FRI, NSW, MEL, K).

Tree to 15 m (often much less). *Bark* smooth, grey and pink, at times white (especially in larger individuals), shedding in thin scales, but usually with some tessellated bark detectable at ground level. *Intermediate leaves* opposite, setose with bristle-glands, ovate, obtuse to acute, 6–9 cm long, 30–50 mm wide; *petioles* 4–10 mm long. *Adult leaves* disjunct, bristle-free, dull and often grey-green, weakly discolorous, amphistomatic, narrow-lanceolate to lanceolate, acuminate, 5–15 cm long, 6–30 mm wide; *petioles* 6–19 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* to 7-flowered; *peduncles* 0–2 mm long; *pedicels* 1–5 mm long; intermediate internodes 0–4 mm long; basal internode 1–4 mm long. *Mature buds* pyriform, 3–5 mm long, 2–3 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 5–9 mm long, 4–7 mm diam. Figs 117, 120.

Distinguished within the series by the petiolate, non-cordate, dull and often greyish-green, non-neotenous adult leaves.

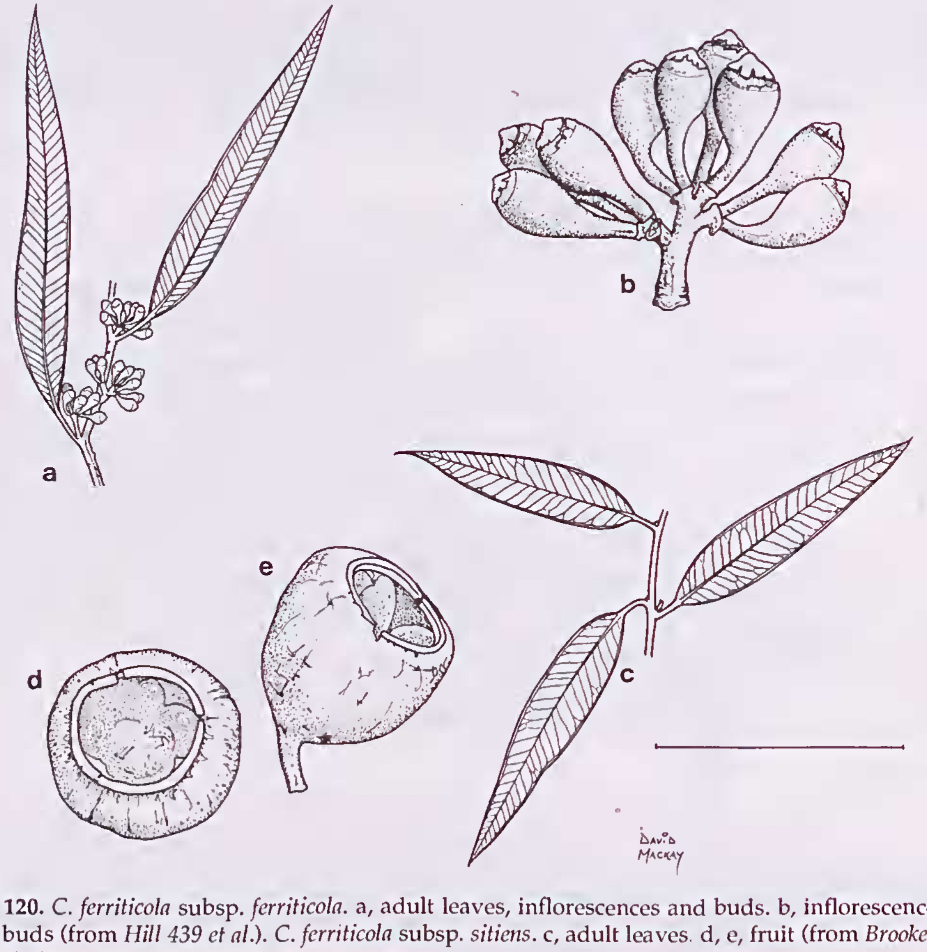

Fig. 120. *C. ferriticola* subsp. *ferriticola*. a, adult leaves, inflorescences and buds. b, inflorescence and buds (from *Hill 439 et al.*). *C. ferriticola* subsp. *sitiens*. c, adult leaves. d, e, fruit (from *Brooker 10704*). Scale bar: a, d = 5 cm; b, c = 1 cm.

Cases (e.g. *Hill 438 et al.*) of inflorescence 'flexibility' are occasionally found (see under *C. candida*).

Known from the Pilbara region and southward to Mt Augustus and the Meekatharra district, and the Gibson Desert (Fig. 121).

Two geographic subspecies can be recognised.

1 Adult-leaf petioles 7–19 mm long; petioles of juvenile or early intermediate leaves 6–13 mm long .... 106A. subsp. **ferriticola**

1* Adult-leaf petioles 3–6 mm long; petioles of juvenile or early intermediate leaves 1–3 mm long .... 106B. subsp. **sitiens**

106A. ACULLFE **Corymbia ferriticola** *(Brooker & Edgecombe) K.D. Hill & L.A.S. Johnson* subsp. **ferriticola**

Tree to 15 m but often much less. *Bark* grey and pink, or white in large individuals. *Intermediate leaves* 6–9 cm long, 30–50 mm wide; *petioles* 6–13 mm long. *Adult leaves* disjunct, dull, grey-green, narrow-lanceolate to lanceolate, acuminate, 5–15 cm long, 7–31 mm wide; *petioles* 7–19 mm long. *Mature buds* pyriform, 3–5 mm long, 2–3 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 5–8 mm long, 4–7 mm diam. Fig. 120.

Flowering: Dec (one record only).

Sporadic and localised, on shallow to extremely skeletal soils on siliceous outcrops. It often occurs on haematitic substrates in the Hamersley Range region, whence the epithet, but is also present on quite different rocks in other areas, for instance at Mt Augustus, and is not an indicator of 'ironstone'.

Subspecies *ferriticola* is known from the Pilbara region and south and south-east of there (Fig. 121).

Occasional hybrids with *C. candida* subspp. *dipsodes* and *lautifolia* (q.v.) are known from intermediate habitats in the Pilbara region and to the east and south-east to Mt Augustus and near Meekatharra (Appendix 1).

Conservation status: Locally frequent over a wide area, not considered to be at risk.

Selected specimens (from 20 examined): Western Australia: power line track towards Mt Brockman, 29 km S of Tom Price railway, *Brooker 10097*, 13 Oct 1988 (CANB, NSW); road to radio tower S of Paraburdoo, *Brooker 10105*, 15 Oct 1988 (CANB, NSW); Hamersley Gorge, near rockpool, *Hill 442, Johnson, Blaxell, Brooker & Edgecombe*, 31 Oct 1983 (NSW); Wittenoom Gorge, *Hill 438, 439, Johnson, Blaxell, Brooker & Edgecombe*, 30 Oct 1983 (NSW); 26.6 km S of Karalundi turnoff on Meekatharra to Kumarina road, then 2.5 km W, *Brooker 9235, 9236*, 16 Apr 1986 (CANB, NSW); 71.5 km W of Newman on track to Tom Price, *Hill 488, Johnson, Blaxell, Brooker & Edgecombe*, 1 Nov 1983 (NSW); Round Hill, W of Capricorn roadhouse, *Brooker 8199*, 5 July 1983 (CANB, NSW); above Flintstones, Beedoboondum, S side of Mt Augustus, *Johnson 9347 & B. Briggs*, 3 Aug 1991 (NSW, CANB, DNA, PERTH); 18 miles [29 km] north of Meekatharra, *Speck 1086*, 27 June 1961 (CANB, NSW).

106B. ACULLFS **Corymbia ferriticola** *(Brooker & Edgecombe) K.D. Hill & L.A.S. Johnson* subsp. **sitiens** *L.A.S. Johnson & K.D. Hill*, **subsp. nov.**

Ab subspecie *ferriticola* combinatione characterum sequentium distinguitur: folia juvenilia adultaque et petioli breviores; folia adulta plus viridia vel flavoviridia et nitentiora, etiam crassiora; fructus aliquanto majores.

Type: Western Australia: 49.9 km S from N end of Alfred and Marie Range, between range and Lake Gruszka, *M.I.H. Brooker 10704*, 14 Apr 1991 (holo NSW; iso CANB, DNA, PERTH).

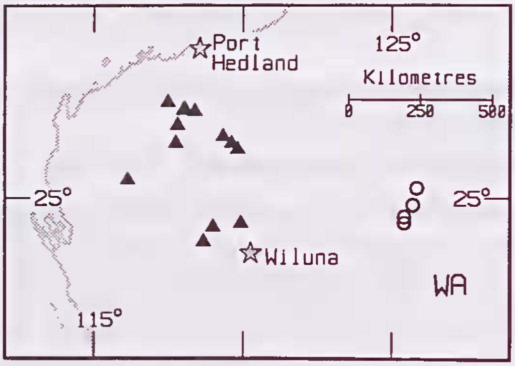

Fig. 121. Distribution of *C. ferriticola* subsp. *ferriticola* (triangle), *C. ferriticola* subsp. *sitiens* (circle).

Tree to 8 m. *Bark* white, slowly becoming grey, brown and pink. *Intermediate leaves* 4–6 cm long, 15–25 mm wide; *petioles* 1–3 mm long. *Adult leaves* disjunct, dull to semi-glossy, grey-green to yellow-green, narrow-lanceolate to lanceolate, acuminate, 3–7 cm long, 4–7 mm wide; *petioles* 3–6 mm long. *Mature buds* not seen. *Fruits* ovoid, 7–9 mm long, 6–8 mm diam. Fig. 120.

Flowering: Not recorded.

Distinguished from subsp. *ferriticola* by the shorter adult and juvenile or intermediate leaves and petioles, the rather brighter green or yellow-green and slightly glossier adult leaves, and the slightly larger fruits. Adult leaves also tend to be thicker (dried leaves 0.22–0.28 mm thick in subsp. *ferriticola*, 0.30–0.42 mm thick in subsp. *sitiens*).

Subspecies *sitiens* generally occurs on stony sites in the southern Gibson Desert of Western Australia (Fig. 121), although a few records are from sites not specifically indicated as being stony.

Specimens from the south-east of the range of subsp. *ferriticola* are intermediate between the two subspecies in leaf thickness and fruit size, but they group with that subspecies in petiole length and in leaf colour and texture.

The epithet is from the Latin *sitiens*, thirsting, from the very dry desert habitat.

Conservation status: Poorly collected over a rather limited area, but in extremely remote country and unlikely to be at risk.

Selected specimens (from 8 examined): Western Australia: Alfred and Marie Range, rocky undulating plain to E of NW hills, W of next hills, *Brooker 10697*, 13 Apr 1991 (CANB, AD, NSW, PERTH); Mt Beadell, 230 km ENE of Carnegie, *B. Briggs 3552a*, 12 June 1970 (NSW); WNW of Notabilis Hill, SE of Mt Beadell, *Brooker 10679*, 12 Apr 1991 (CANB, DNA, NSW, PERTH); 40 miles [64 km] W of Mt Samuel, *H. Johnson NT 5140*, 20 May 1958 (DNA, NSW).

107. ACULLI **Corymbia aspera** *(F. Muell.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus aspera* F. Muell., J. Linn. Soc., Bot. 3: 95 (1859).

Type citation: 'Hab. In planitiebus arenoso-rupestribus (Sandstone table-land) plus minus elevatis ad flumina Victoria et Sturt's Creek, in terra Arnheim's Land necnon prope sinum Carpentaria satis vulgaris, Anth. vere.'

Type: Northern Territory: Upper Victoria River, *F. Mueller*, Dec 1855 (lecto MEL; isolecto BRI, K; here designated).

Tree to 10 m, rarely to 20 m. *Bark* smooth, grey or pink to white, shedding in thin scales, often irregularly persistent and tessellated on lower trunk. *Intermediate leaves* opposite, setose with bristle-glands, ovate, obtuse or apically rounded, to 12 cm long, 60 mm wide; *petioles* 0–2 mm long. *Adult leaves* (neotenous) opposite, discolorous, amphistomatic, setose with bristle-glands lacking simple hairs, ovate to oblong-elliptical, apically rounded, cordate, 1.5–6.5 cm long, 7–35 mm wide; *petioles* 0–3 mm long; *oil glands* abundant but obscured. *Inflorescences* highly condensed (sometimes so much so that the whole lateral inflorescence may have the appearance of a many-flowered cluster); *umbellasters* to 7-flowered; *peduncles* 0–2 mm long; *pedicels* 2–7 mm long; intermediate internodes reduced; basal internode 0–6 mm long. *Mature buds* pyriform, 4–6 mm long, 3–4 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, shallowly hemispherical. *Fruits* ovoid, 5–8 mm long, 4–6 mm diam. Fig. 117.

Flowering: Nov–Dec.

C. *aspera* is distinguished by the thin-textured, neotenously sessile and cordate adult leaves which are apically rounded. The related species C. *candida* and C. *ferriticola* both develop bristle-free, non-cordate and acute adult leaves (often delayed in C. *candida*, which differs in the acute intermediate and adult leaves, larger fruits and more consistently white powder-bark). C. *aspera* also frequently shows an irregular short stocking of persistent bark, which is seldom present in mature trees except at ground level in the related species. Distributed from north-west of Halls Creek in Western Australia to east of Mt Isa in Queensland, to south of Tennant Creek and north to the Roper River in the Northern Territory (Fig. 119).

Cases (e.g. *Byrnes 2004*) of inflorescence 'flexibility' are occasionally found (see comment under C. *candida*).

C. *aspera* occurs on skeletal sandy soils on siliceous sandstone outcrops, often growing in cracks in bare rock.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 34 examined): Western Australia: Mt King, near 'Bedford Downs', *Rodd 8264*, 24 Oct 1974 (NSW); Piccaninny Gorge, Bungle Bungle National Park, *Hill 3491*, 27 Nov 1988 (NSW); Hidden Valley, Kununurra, *Brooker 7785*, 5 Nov 1982 (CANB, NSW).

Northern Territory: Roper River area, *Dunlop, 7375*, 29 Nov 1987 (DNA, CANB, MEL, NSW, PERTH); bluff to W of Victoria River crossing, *Hill 3351, Johnson & Stanberg*, 17 Nov 1988 (NSW); along Victoria Highway near bridge over Victoria River, *Byrnes 2003, 2004*, 19 Oct 1970 (CANB, AD, DNA, NSW); Bessie Spring, 'MacArthur River' station, *Russell-Smith 6225 & Lucas*, 27 Oct 1988 (DNA, BRI, NSW); c. 5 km NE of 'Camfield' station, *Dunlop 5569*, 8 Oct 1980 (DNA, AD, BRI, CANB, MEL, NSW, PERTH); 27.7 miles [45 km] S of Elliott, *Chippendale NT 3902 & Johnson*, 7 Oct 1957 (DNA, NSW); 30 km N of Three Ways, Short Range, *Thompson 891*, 24 Oct 1985 (DNA, NSW); Turkey Creek, Murchison Range, *Latz 9807*, 29 Sep 1983 (DNA, NSW).

Queensland: 57 km E of Wollogorang on road to Burketown, *Hill 1032, Johnson & Benson*, 7 Aug 1984 (NSW); entrance gate to Lawn Hill National Park, *Hill 3574 & Stanberg*, 4 Dec 1988 (NSW); Dugald River, *Cole 283 & Provan*, 30 Oct 1962 (BRI, NSW); Moondarra Lake, NE of Mt Isa, *B. Briggs 3693*, 23 June 1970 (NSW); 1 km W of Mt Dora mine, 21°40'S 140°79'E, *Neldner 2464 & Stanley*, Apr 1986 (BRI, NSW).

108. ACULLP **Corymbia punkapitiensis** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Asperarum* combinatione characterum sequentium distinguitur: folia adulta crassa (0.40–0.50 mm), neotenice sessilia et cordata, apice rotundata, plusminusve laevia; folia intermedia magna, sparse setosa vel laevia.

Type: Western Australia: Punkapiti, Walter James Range, *A. Kalotas 1658*, 20 May 1984 (holo DNA [photo NSW]; iso PERTH).

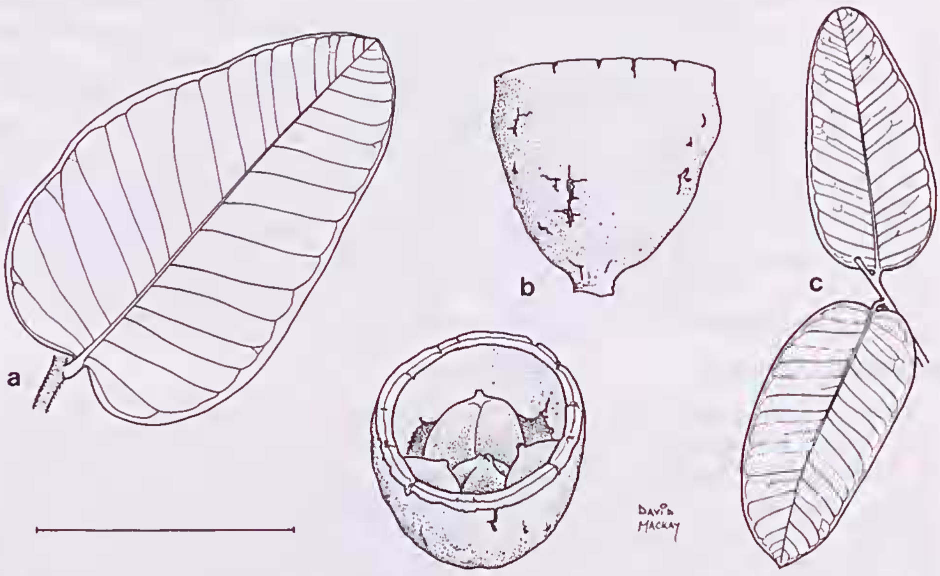

Fig. 122. *C. punkapitiensis*. a, intermediate leaf. b, fruit. c, adult leaves (a, from *Kalotas 1658*, b, c from *Latz 2672*). Scale bar: a, c = 5 cm; b = 1 cm).

Tree to 6 m. *Bark* smooth, white, shedding in thin scales. *Intermediate leaves* opposite, amphistomatic and concolorous, ovate, rounded, bristle-free or sparsely setose with bristle-glands lacking simple hairs, 6–12 cm long, 35–70 mm wide; *petioles* 1–2 mm long. *Adult leaves* (neotenous) opposite to slightly disjunct, amphistomatic and concolorous, ovate, rounded, bristle-free or sparsely setose with bristle-glands, 4–7 cm long, 20–40 mm wide; *petioles* 2–3 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* c. 7-flowered; *peduncles* 0–<1 mm long; *pedicels* 0–4 mm long; intermediate internodes reduced; basal internode 0–1 mm long. *Mature buds* not seen. *Fruits* ovoid to campanulate, 7–8 mm long, 6–8 mm diam. Fig. 122.

Flowering: Not recorded.

C. punkapitiensis is distinguished by the thick (0.40–0.50 mm), neotenously sessile, cordate, apically rounded, more or less non-setose adult leaves, and the large, non-setose or sparsely setose intermediate leaves. The related *C. aspera* shares the rounded leaves, but its adult leaves are thinner (0.25–0.32 mm) and consistently setose, and its fruits are slightly smaller. *C. candida* and *C. ferriticola* both develop non-setose, non-cordate and acute adult leaves (often delayed in *C. candida*, which differs in the acute intermediate and adult leaves).

The only available material has leaves as described, but the specimens show some characteristics of reversion shoots from damaged canopies. It is unknown whether more fully adult leaves may sometimes develop, although the specimens have flowered and fruited.

Known only from the Walter James Range, near Punkapiti (Fig. 119), growing on stony quartzite ridges. We have not seen this species in the field.

The epithet is from the Aboriginal community of Punkapiti, which is the type locality, with the Latin termination *-ensis*, indicating an inhabitant.

Conservation status: Known from one area only. 2K.

Specimen examined: Western Australia: Walter James Range, *Latz 2672*, 9 Apr 1972 (DNA, PERTH).

ACUS Series **Grandifoliae**

Definite, thick and regularly tessellated bark absent, even at ground level, bark wholly smooth, white to grey or pinkish. Adult leaves glossy, lamina usually somewhat twisted, venation openly reticulate (Fig. 123). Bristle-glands not bearing simple hairs, present sparingly only on young juvenile or less often on some intermediate leaf-stages (chiefly in *C. grandifolia* subsp. *lamprocardia*). Inflorescences at flowering borne mainly on leafless portions of branchlets, condensed, not branched to the second degree (condensed botryoids of umbellasters) (Fig. 123).

The condition of inflorescences being mostly lateral and regularly on lengths of stem that have become leafless is less marked in *C. dallachiana*. Axillary buds are often rather large, with pointed scale-like unexpanded leaves (this feature occurs, but is less pronounced, in some other series, e.g. *Polysciadae*). New growth is often bluish because of the rubbery cuticle (not powdery-pruinose).

A widespread series across the tropics and through central Australia, mainly in level rather than rocky sites, comprising four species that show a geographic replacement pattern (Figs. 93, 124) with some intergradation in contact zones between the component species, but otherwise consistent in each case over very considerable areas. We group the first two species into Superspecies *Aparrerinja* (*C. dallachiana* and *C. aparrerinja*) (Appendix 3).

109. ACUSSD **Corymbia dallachiana** *(Benth.) K.D. Hill & L.A.S. Johnson*, **comb. nov.**

Basionym: *Eucalyptus tessellaris* F. Muell. var. *dallachiana* Benth., Fl. Austral. 3: 251 (1867).

Type citation: 'Queensland, Bowman; Rockhampton, Dallachy.'

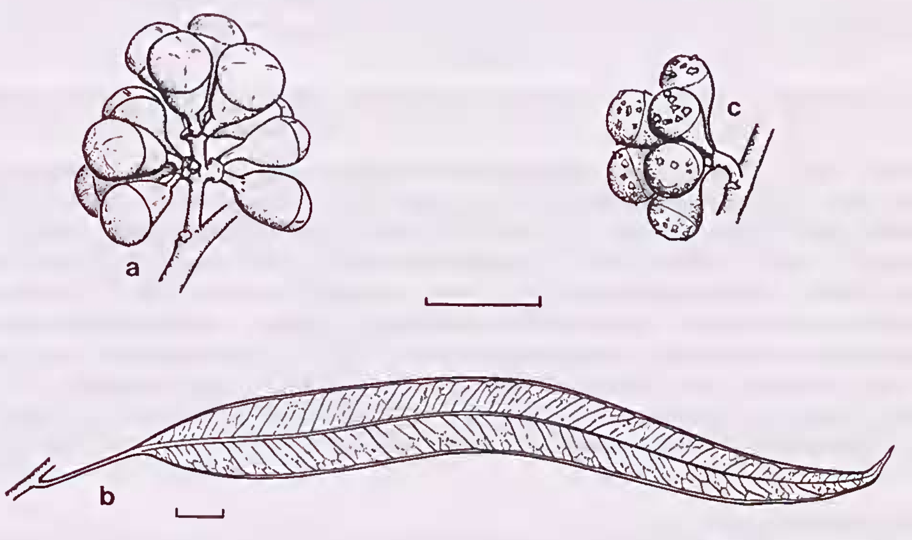

Fig. 123. Inflorescences and leaf venation of series *Grandifoliae*. a, inflorescence of *C. dallachiana* (from *Batianoff 3369*). b, leaf of *C. dallachiana* (from *Hill 3722 & Stanberg*). c, inflorescence of *C. aparrerinja* (from *Forde 32*). Scale bar = 1 cm.

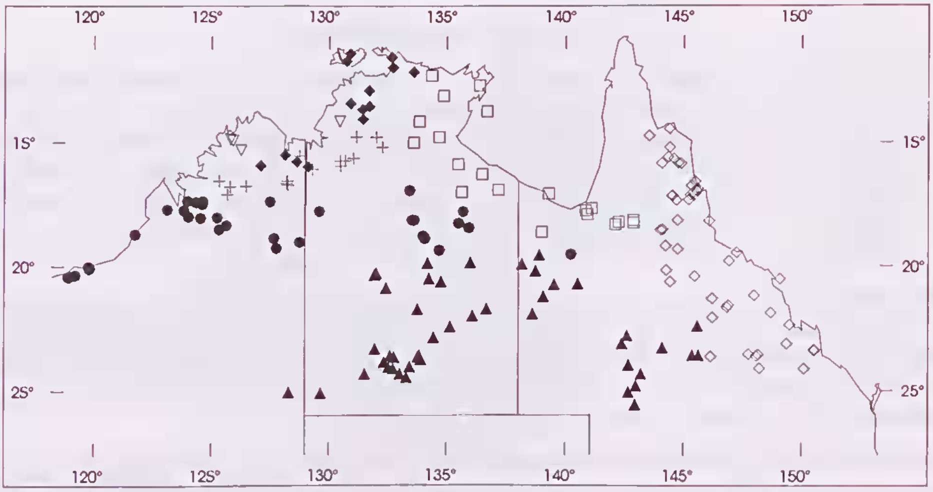

Fig. 124. Distribution of *C. dallachiana* (open diamond), *C. aparrerinja* (solid triangle), *C. flavescens* (solid circle), *C. grandifolia* subsp. *grandifolia* (square), subsp. *longa* (solid diamond), subsp. *lamprocardia* (plus), subsp. *lamprocardia*–subsp. *longa* (open triangle).

Type: Queensland: Rockhampton, *J. Dallachy 109* (lecto K; isolecto MEL). The Dallachy collection is here nominated as lectotype since it was distributed to K and also has more precise collection data. The status of this taxon as a variety of *E. tessellaris* caused some controversy (see Maiden, Crit. Rev. Eucalyptus 4: 193, 1919), and Maiden (1913, see below) first transferred it (still as a variety) to *E. clavigera*, and subsequently (Maiden 1915) treated it as synonymous with *E. papuana*, to the catch-all concept of which it has subsequently been referred in Queensland. The spelling of the epithet by the linguistically competent Bentham is clearly a deliberate latinisation, and the 'i' is not to be changed to a 'y' (cf. Appendix 4).

≡ *E. clavigera* A. Cunn. var. *dallachiana* (Benth.) Maiden, J. & Proc. Roy. Soc. New South Wales 47: 77 (1913). Maiden's treatment is discussed above.

Tree to 15 m (or sometimes more). *Bark* smooth, grey and pink to white, shedding in thin scales. *Intermediate leaves* opposite or slightly disjunct, bristle-free, ovate, acuminate or apiculate, 11–25 cm long, 50–100 mm wide; *petioles* 6–20 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, lanceolate to broad-lanceolate, rarely narrower, acuminate, 10–26 cm long, 11–34 mm wide, not highly glossy, the tertiary venation not obscured; *petioles* 14–38 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* 3–>3(–7)-flowered; *peduncles* 0–2 mm long; *pedicels* 2–6 mm long; intermediate internodes reduced; basal internode 2–5 mm long. *Mature buds* pyriform, 5–7 mm long, 4–5 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical, sometimes apiculate. *Fruits* ovoid, 9–13 mm long, 7–10 mm diam. Fig. 123.

Flowering: Nov–Dec.

Distinguished within the series by the combination: bark grey to pink (not usually powdery white, though sometimes so at least in the Emerald-Springsure region); intermediate leaves large, broad-lanceolate; adult leaves with a thinner cuticle than in *C. aparrerinja* (and thus not markedly varnished-glossy) and with the fine tertiary venation not obscured or glossed over.

This species is confined to Queensland, widely distributed and abundant overall though usually as scattered trees, from central-northern Cape York Peninsula to Rockhampton and south of Emerald, extending to some offshore islands and west to the Great Dividing Range near Jericho (Fig. 124).

C. dallachiana is widespread in grassy woodland on a variety of substrates, mainly on somewhat clayey soils of moderate fertility. Limited intergradation occurs with *C. aparrerinja* (q.v.) west of Jericho (Fig. 124 and Appendix 1), where the ranges and substrate-types of the species meet. The two species are close and are grouped herein as Superspecies *Aparrerinja* (Appendix 3). Hybrids (or very local intergradation) also occur with *C. grandifolia* and *C. gilbertensis*, as well as an intersectional hybrid with *C. dimorpha* of section *Ochraria* (Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 73 examined): Queensland: 6.4 km N of Musgrave telegraph station, *Hind 2038 & Ingram*, 16 Aug 1977 (NSW); 8 km S of 'New Laura' ranger station on road, *Hill 1077, Johnson & Blaxell*, 13 Aug 1984 (NSW); c. midway between Mt Molloy and Mareeba, *Irvine 1690*, 8 Dec 1975 (QRS, NSW); c. 11 km from Cairns to Mareeba road on Tinaroo Creek Road, *Clarkson 2717*, 20 Nov 1979 (BRI, CANB, NSW, QRS); Chillagoe, *Doran*, 9 Oct 1911 (NSW, 331007–331010); Alma Den [Almaden], *White 1390*, Feb 1922 (BRI, NSW); near Einasleigh, *Johnson & Pryor*, 21 Oct 1964 (NSW); 2 miles [3.2 km] W of 'Mt Sturgeon' station, *Perry 3649*, 27 June 1953 (CANB, BRI, NSW); Shaw Island, *Batianoff 3369 & Dalliston*, 6 Nov 1985 (BRI, NSW); 45.3 km N of Hughenden, *Hill 3722 & Stanberg*, 28 July 1990 (NSW, BRI, CANB); c. 5 miles [8 km] S of Nebo, *Storey & Yapp 1*, 17 June 1962 (CANB, NSW); St Lawrence, *Tate*, 4 Dec 1911 (NSW 314256); Rockhampton, *Dietrich 1549, 1944, 1990*, 1865 (CANB, NSW); Emerald, *Blake 10226*, 26 Nov 1935 (BRI, CANB, K, L, MO, NSW, PRE); 3 miles [5 km] W of Rannes, *Lazarides 6898*, 5 July 1963 (CANB, NSW).

110. ACUSSI **Corymbia aparrerinja** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Affinis C. *dallachianae* sed cortice candido et foliis (praesertim adultis) per cuticulam incrassatam valide vernicoso-nitentibus venatione tertiaria saepe subobscura distinguenda.

Type: Northern Territory: Gosse Range, S.W. Macdonnell Ranges, *H. Basedow*, May 1925 (holo NSW 10075, see below).

[*Eucalyptus papuana* F. Muell. var. *aparrerinja* Blakely, Trans. & Proc. Roy. Soc. South Australia 60: 154 (1936), nom. invalid. Published without a Latin diagnosis, with the type citation: 'Deep Well Station, Charlotte Waters, A.M. Kleinig, 20/1/1925; Crown Point and Cunningham's Gap; Ross River Gorge,...; near Temple Bar, L.K. Ward; Gosse Range, S.W. Macdonnell Ranges;..., Dr. H. Basedow, Borroloola,..., G.F. Hill.' Although Blakely cited a number of syntypes, the Basedow collection from Gosse Range was selected by him (in NSW) as representing the variety, and was designated the lectotype by Blake (1953: 223), who reduced the variety to a synonym of *E. papuana*. Although Blakely correctly recognised the existence of a taxon, he did not propose the name *E. aparrerinja* or indeed any binomial, so it is not technically correct to cite 'Blakely ex ...'.]

Tree to 20 m but often much less. *Bark* smooth, white, shedding in thin scales. *Intermediate leaves* opposite, lacking bristle-glands, broad-lanceolate to ovate, acute, to 10 cm long, to 50 mm wide; *petioles* 3–6 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, twisted, narrow-lanceolate to lanceolate, acuminate, 5–16 cm long, 7–20 mm wide, bright green and glossy and with tertiary venation often more or less obscure; *petioles* 8–20 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* to 7-flowered; *peduncles* 0–4 mm long; *pedicels* 2–5 mm long; intermediate internodes reduced; basal internode 2–5 mm long. *Mature buds* pyriform, 6–7 mm long, 5–6 mm diam.; *calyptra* 1/3–1/2 as long as hypanthium, hemispherical. *Fruits* ovoid, 8–10 mm long, 7–9 mm diam. Fig. 123.

Flowering: Erratic, possibly in response to rainfall, recorded in Feb, July, Dec (mainly Dec).

Close to *C. dallachiana*, distinguished throughout its range by the consistently very white bark and the narrow, thick-cuticled leaves (especially in the adult phase), which are bright green and with a varnished-glossy sheen usually more or less obscuring the tertiary venation.

Distributed in arid central regions from around Giles in the extreme east of Western Australia through the Northern Territory to north of Mt Isa and east around the northern Simpson Desert to central Queensland somewhat east of Barcaldine (Fig. 124).

Locally frequent on red siliceous desert sands or sandy red earths, extending in some areas onto shallow or skeletal soils over siliceous substrates. Often along dry stream-lines in sandstone range country in central Australia, more on red sands and sandy loams in the north-west, north and north-east, though these soils may be on flat portions or in pockets on rocky range country. *C. aparrerinja* is the much-publicised 'Ghost Gum' of central Australia, though its range is more extensive than is commonly realised.

Intergradation occurs with *C. flavescens* around Tennant Creek and east across the southern margins of the Barkly Tableland into Queensland. *C. aparrerinja* shows limited intergradation with *C. dallachiana* between Barcaldine and Jericho (Fig. 124, Appendix 1), but the species occur on different substrates and in most places are well separated by substrates unsuitable for either. Interserial hybrids and perhaps some local hybrid swarms with *C. blakei* occur in some intermediate sites south-west of Longreach, and a hybrid is recorded with *C. candida* subsp. *dipsodes* (Appendix 1).

The epithet is a rendering of the name used by Aboriginal people in central Australia for this species as recorded by H. Basedow (fide Blakely 1936).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 67 examined): Western Australia: c. 3 km E of Giles, *Brooker 10830, 10831*, 20 May 1991 (CANB, DNA, NSW, PERTH).

Northern Territory: SE of 'Alexandria' station, *Blake 17919*, 22 May 1947 (BRI); 20 km SE of Barkly Inn, Barkly Highway, *Russell-Smith 1885 & Lucas*, 9 June 1987 (DNA, NSW); 15 km E of Lake Surprise, *Latz 10970*, 22 Oct 1988 (DNA, NSW, BRI, PERTH); track W of Stuart Highway, 95 km S of Tennant Creek, *Fox*, May 1987 (NSW 207881); 28.1 km S of Barrow Creek on highway, *Hill 3248, Johnson & Stanberg*, 8 Nov 1988 (NSW, DNA); Argadargada, horse paddock, *Chippendale NT 361*, 20 Sep 1954 (DNA, NSW); near Ulambaura Spring, Haasts Bluff, *Chippendale NT 2574*, 23 Aug 1956 (DNA, NSW); 1 mile [1.6 km] S of Heavitree Gap, Alice Springs, *Forde 32*, 14 Dec 1955 (CANB, NSW); Gosses Range, *Namatjira per Albrecht*, Feb 1937 (NSW 21483); King Creek, George Gill Range, *Chippendale NT 3652*, 13 Sep 1961 (DNA, NSW); 81.2 km N of Erldunda on highway, *Hill 859, Johnson & Benson*, 10 July 1984 (NSW, CANB, DNA, PERTH); Bloods Range, *Dunlop 1902*, 26 Sep 1970 (DNA); c. 35 miles [56 km] W of Mt Olga, *Latz 1790*, 23 Sep 1971 (DNA).

Queensland: c. 10 km W of Mt Isa turnoff on Camooweal to Burketown road, *Hill 3569 & Stanberg*, 3 Dec 1988 (NSW); 3.3 km N of Camooweal, *Hill 3567 & Stanberg*, 3 Dec 1988 (NSW); Dugald River, *Cole 241 & Provan*, 4 May 1962 (BRI); Cloncurry, *White 228*, 24 June 1922 (NSW); on Carandotta, SE from Urandangie, *Blake 10170*, 13 Nov 1935 (BRI, NSW); near Windorah, *Little 67*, Aug 1968 (NSW); 25.1 km from Longreach on Winton road, *Hill 3866 & Johnson*, 23

May 1991 (NSW, BRI, CANB); 7.8 km E of Barcaldine, *Hill 3866 & Johnson*, 23 May 1991 (NSW); 204.6 km from Quilpie on Windorah road, *Hill 3843 & Johnson*, 21 May 1991 (NSW, BRI, CANB); Mooraberree, c. 40 miles [64 km] ENE of Betoota, *Everist 4100*, 1 Sep 1949 (BRI).

111. ACUSSL **Corymbia flavescens** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Inter species seriei *Grandifoliarum* combinatione characterum sequentium distinguitur: cortex albidus, folia adulta nitentia late lanceolata ad ovata, petioli 5–17 mm longa, inflorescentiae modice condensatae pedunculis 0–2 mm longis pedicellis 1–6 mm longis.

Type: Northern Territory: 10.9 km N of Inverway on track to Duncan Highway, *K. Hill 3528 & L. Stanberg*, 30 Nov 1988 (holo NSW; iso CANB, DNA).

Tree to 15 m (or sometimes more). *Bark* smooth, white, shedding in thin scales. Young shoots and buds often silver with rubbery cuticle. *Intermediate leaves* opposite or disjunct, bristle-free, ovate, obtuse or acute, rounded or sometimes cordate, to 20 cm long, to 150 mm wide; *petioles* 5–12 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, broad-lanceolate to ovate, acute, 6–20 cm long, 20–60 mm wide; *petioles* 5–17 mm long; *oil glands* obscured. *Inflorescences* condensed; *umbellasters* 1–3–>3(–7?)-flowered (most often 3-flowered); *peduncles* 0–5 mm long; *pedicels* 1–6 mm long; intermediate internodes reduced; basal internode 2–4 mm long. *Mature buds* pyriform to clavate; 7–8 mm long, 4–5 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical. *Fruits* ovoid, 10–12 mm long, 9–11 mm diam. Fig. 125.

Flowering: Nov (also erratically, possibly in response to rainfall, recorded in May, June).

Distinguished within the series by the combination: bark white, adult leaves glossy, broad-lanceolate to ovate, petioles 5–17 mm long, inflorescences moderately condensed with peduncles 0–2 mm long and pedicels 1–6 mm long.

Distributed from east-north-east of Port Hedland and the Dampier Peninsula in Western Australia to north of Mt Isa in north-western Queensland, south to near Tennant Creek and north to near Larrimah in the Northern Territory (Fig. 124).

Abundant (though usually widely spaced) on red-earth plains in dry monsoon savannah woodland or shrubland dominated by *Acacia* species. Intergradation occurs with *C. grandifolia* north of Daly Waters, and with *C. aparrerinja* around Tennant Creek and east of there (Fig. 124). Individuals from between the north-western extension of the Great Sandy Desert and Port Hedland have shorter pedicels, possibly a result of past introgression from *C. candida*, though the species are generally distinct in aspect in this region. These occurrences are now separated from the remainder of the range of *C. flavescens* by the Great Sandy Desert. Interserial hybrids are also recorded with *C. aspera* and *C. dendromerinx* (Appendix 1), and the hybridogenous species *C. paractia* (q.v.) is apparently derived from *C. dendromerinx* and *C. flavescens*.

The epithet is from the Latin *flavescens*, becoming yellow, referring to the yellowish-green foliage and yellowish branchlets.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 49 examined): Western Australia: Highway 1, at West Strelley River, *Johnson 9285 & B. Briggs*, 26 July 1991 (NSW, BRI, DNA, PERTH); La Grange mission, *Beard 5698*, 4 July 1968 (PERTH, NSW); 109.8 km ENE of Broome towards Derby, *Brooker 10119*, 19 Oct 1988 (CANB, NSW); May River, *Fitzgerald 506*, May 1905 (NSW); c. 2 km NE of NW end of Grant Range, *Hill 3453, Johnson & Stanberg*, 24 Nov 1988 (NSW, CANB, PERTH); 17.7 km SW of Windjana Gorge turnoff on Gibb River Road, *Hill 3427, Johnson & Stanberg*, 23 Nov 1988 (NSW, CANB, PERTH); 2 miles [3.2 km] NE of Rexona Bore, 'Cherrabun' station, *Lazarides 6481*, 14 Aug 1959 (CANB, NSW); 75.2 km from highway on road to 'Bedford Downs', *Hill 3465, Johnson &*

Stanberg, 25 Nov 1988 (NSW); 48 miles [77 km] from Billiluna towards Ruby Plains, *Gittins 2331*, Aug 1971 (NSW); 'Carranya' station homestead, *Hill 995, Johnson & Benson*, 2 Aug 1984 (NSW).

Northern Territory: 2 km S of Calvert River crossing, *Thompson 512*, 23 May 1984 (DNA, NSW); 50 miles [80 km] N of Daly Waters, *Winkworth 1110*, 29 Mar 1955 (BRI ex CANB); 2 miles [3.2 km] E of 'New Walhallow' homestead, *Latz 1824, 1825, 1826*, 14 Nov 1971 (DNA, BRI, NSW); near 'Rockhampton Downs' homestead, *Blake 17859*, 19 May 1947 (BRI); Powell Creek, Newcastle Waters, *Spencer*, 1902 (NSW 10153, 10154, 10155); 15 miles [24 km] due N of 'Brunette Downs' homestead, *Latz 1822*, 13 Nov 1971 (DNA, NSW); 8.4 km S of Banka Banka on Stuart Highway, *Hill 880, Johnson & Benson*, 13 July 1984 (NSW).

Queensland: Adels Grove, *de Lestang 248*, 4 Aug 1946 (BRI); Dugald River, *Cole 236 & Provan*, 30 Apr 1962 (BRI).

Fig. 125. *C. flavescens*. a, intermediate leaf. b, adult leaves, inflorescences and buds. c, d fruits (a from *Spencer NSW 10154*, b from *Hill 3528 & Stanberg*, c, d from *Gittins 2331*). Scale bar = 1 cm.

112. ACUSSO **Corymbia grandifolia** *(R. Br. ex Benth.) K.D. Hill & L.A.S. Johnson,* **comb. nov.**

Basionym: *Eucalyptus grandifolia* R.Br. ex Benth., Fl. Austral. 3: 250 (1867).

Type citation: 'N. Australia. Islands of the Gulf of Carpentaria, R. Brown (Herb. R. Brown).'

Type: Queensland: Sweers & Allens Is., Gulf of Carpentaria, *R. Brown*, 17 Nov 1802 and 20 Nov 1802 (syn K (2 sheets), isosyn BM (2 sheets), E (2 sheets), NSW (3 sheets)). The specimens on all sheets are similar, and appear to have come from a single gathering. No useful purpose would be served by designating any one sheet as a lectotype, apart from excluding all isotypes since none can be unequivocally matched with either sheet in K.

Tree to 25 m. *Bark* smooth, white, shedding in thin scales, occasionally patchily adherent near base of trunk but not regularly tessellated. *Intermediate leaves* opposite to disjunct, setose with bristle-glands not bearing simple hairs, which are present to varying degrees or are absent at later stages, ovate to orbicular, acute to rounded, 8–18 cm long, 60–160 mm wide; *petioles* 8–22 mm long. *Adult leaves* disjunct, amphistomatic and concolorous, narrow-ovate (or sometimes lanceolate) to ovate or orbicular, rounded to acute, 8–16 cm long, 30–100 mm wide with silvery rubbery cuticle when new; *petioles* 5–22 mm long; *oil glands* abundant but obscured. *Inflorescences* condensed; *umbellasters* to 7-flowered; *peduncles* extremely reduced, 0–1 mm long; *pedicels* 8–50 mm long; intermediate internode single, 0–1 mm long; basal internode 1–3 mm long, 3 mm diam. *Mature buds* pyriform to clavate; 10–12 mm long, 7–8 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical, apiculate. *Fruits* ovoid, 10–22 mm long, 9–16 mm diam. Fig. 126.

Flowering: July–Nov.

C. grandifolia is locally abundant in medium-height to tall savannah woodlands on a range of sites, usually flat, often alluvial floodplains, but sometimes on shallow soils on elevated sites. The habitat ranges from quite high-rainfall regions to considerably drier zones but always in monsoon savannah country, through much of the central Kimberley region of Western Australia, into the Northern Territory, south to about Mataranka and east to the Gulf of Carpentaria and its islands, and eastward to Normanton and the Gilbert River in Queensland (Fig. 124).

A wide variation, to some extent clinal, but certainly not smoothly so, occurs across the range. This is seen most strikingly in pedicel length, which ranges from very long in wetter parts of the distribution of subspp. *longa* and *lamprocardia* to about 1/5 as long in subsp. *grandifolia*. A limited zone of intergradation occurs in the south-east between subsp. *grandifolia* and C. *flavescens*, evident in very short pedicels and intermediate leaf form (Fig. 124, Appendix 1). Shape and size of leaves, petiole length, and indumentum also display variation, only partly correlated with pedicel length. Adult leaves are broadest in the central west of the range (subsp. *lamprocardia*), and there bristle-glands occur on early adult stages. Adult leaves are narrower, thicker and bristle-free earlier in the leaf-series towards the east, and also to some extent towards the northernmost parts of the Northern Territory and the north-eastern Kimberley region. Petioles also are shorter in the east of the range. Leaf-shape also varies markedly ontogenetically, early leaves in a seasonal growth unit often being narrower, lanceolate or narrow-elliptical in shape. Later leaves are often broader, sometimes orbicular or deltoid (in subsp. *lamprocardia*) and more or less cordate. Later again, leaves may be narrower, but this stage appears to be largely suppressed in subsp. *lamprocardia*.

Fig. 126. *C. grandifolia* subsp. *grandifolia*. a, leaf. d, fruit; subsp. *longa*. b, leaf. g, buds. e, fruit; subsp. *lamprocardia*. c, leaf. f, fruit. (a from *Johnson & Pryor NSW 312422*, b, e from *Lazarides 6704*, c, f from *Brooker 10967*, d from *Johnson & Pryor NSW 312423*, g from *Tindale 6101 & Dunlop*). Scale bar: a, b, c = 3 cm; d, e, f = 1 cm; g = 2 cm.

Three ecogeographic, somewhat intergrading, subspecies can be recognised.

1 Adult leaf-laminae not (or rarely) cordate and with proximal edges often diverging at acute angles to the petiole, length:breadth ratio 1.6:1–3:1 (not deltoid, the greatest width usually >1/4 of the distance from base to tip), bristle-glands not persistent on intermediate-phase shoots and leaves

2 Longest petioles of adult leaves 5–15 mm long, longest pedicels (bearing mature buds or fruit) 8–23 mm long, largest mature fruits 10–17 mm long .... 112A. subsp. **grandifolia**

2* Longest petioles of adult leaves 12–30 mm long, longest pedicels (10-)15–40 (–50) mm long, largest mature fruits 15-22 mm long .... 112B. subsp. **longa**

1* Adult leaf-laminae cordate or with proximal edges at (or almost at) right angles to petiole, length:breadth ratio 1:1 to 2:1 (or if up to 2.5:1 then deltoid-ovate with the greatest width at <1/4 of the distance from base to tip), bristle-glands usually persistent on at least part of intermediate-phase (and sometimes adult) shoots or leaves .... 112C. subsp. **lamprocardia**

112A. ACUSSOG **Corymbia grandifolia** *(R. Br. ex Benth.) K.D. Hill & L.A.S. Johnson* subsp. **grandifolia**

Tree to 25 m but often less. *Intermediate leaves* with few bristle-glands, or none when mature, ovate to broad-ovate. *Adult leaves* lanceolate to ovate but not distinctly cordate or deltoid, 8–16 cm long, 30–80 mm wide; petioles 5–15 mm long. *Pedicels* 8–23 mm long. Fruits 10–17 mm long, 9–13 mm diam. Fig. 126.

Flowering: Nov–Dec (and probably earlier).

Characterised among the subspecies by the non-cordate, lanceolate to ovate or ovate-oblong adult leaves with short petioles, the absence or non-persistence of bristle-glands on mature intermediate or adult leaves, the relatively short pedicels and the rather smaller fruits than those of subsp. *longa*.

Locally abundant, usually on level sites (but not stream-banks), from the lower eastern parts of the Arnhem Land coast in the Northern Territory south along the western and southern sides of the Gulf of Carpentaria to south of Normanton and the Gilbert River in Queensland. The range of subsp. *grandifolia* adjoins that of subsp. *longa* in the north and intergradation doubtless occurs there, but no contact with subsp. *lamprocardia* is known (Fig. 124).

Limited intergradation occurs in contact zones with the more southern and dry-country species C. *flavescens* and also apparently with the eastern species C. *dallachiana* (Fig. 124, Appendix 1).

Conservation status: Locally abundant over a wide area, not considered to be at risk.

Selected specimens (from 20 examined): Northern Territory: 0.5 km E of Ramingining turnoff on Gove road, *Hill 3915 & Stanberg*, 25 Aug 1991 (NSW, CANB, DNA); Hemple [Hempel] Bay, Groote Eylandt, *Specht 330B*, 30 Apr 1948 (CANB, NSW); 141.7 km from Port Roper turnoff on Roper Bar to Borroloola road, *Hill 4130 & Stanberg*, 26 Sep 1991 (NSW, CANB, DNA).

Queensland: Normanton, *Blake 12481*, 7 Aug 1936 (BRI, NSW); 20 miles [32 km] S of Normanton, *Johnson & Pryor*, 19 Oct 1964 (NSW 312422); 25 miles [40 km] S of Normanton, *Johnson & Pryor*, 20 Oct 1964 (NSW 312423); Gilbert River, *White 1393*, 19 Feb 1922 (BRI, NSW).

112B. ACUSSOL **Corymbia grandifolia** *(R. Br. ex Benth.) K.D. Hill & L.A.S. Johnson* subsp. **longa** *L.A.S. Johnson*, **subsp. nov.**

Inter subspecies *C. grandifoliae* combinatione characterum sequentium distinguitur: folia intermedia adultaque sine setoglandulis persistentibus, folia adulta lanceolata ad late ovata (rare suborbicularia) nec definite cordata nec deltoidea, petioli 12–30 mm longi, pedicelli plerumque 15–40(–50)mm longi, fructus maturi 15–22 mm longi.

Type: Northern Territory: 10 miles [16 km] NE of Ooloo [Oolloo] Homestead [i.e. at c. 14°02'S 131°20'E], *M. Lazarides 6704*, 2 Aug 1961 (holo NSW; iso CANB).

Tree to 20(25?)m, often less. *Intermediate leaves* with few bristle-glands (or none when mature), broad-ovate to suborbicular, only rarely some of them cordate. *Adult leaves* lanceolate to ovate or broadly ovate-oblong but not (or very rarely) distinctly cordate or deltoid, 8–18 cm long, 30–80(–100) mm wide; *petioles* 12–30 mm long. *Pedicels* (10-)15–40(–50) mm long. *Fruits* 15–22 mm long, 12–16 mm diam. (Fig. 126).

Flowering: July–Sep (and probably later).

Characterised among the subspecies by the usually non-cordate, lanceolate to broad-ovate or ovate-oblong (not cordate or deltoid-ovate) adult leaves, long petioles, long pedicels, and the relatively large fruits.

Locally abundant, generally on fairly level sites but often on somewhat more siliceous substrates than subsp. *lamprocardia*, in sub-coastal parts of the Northern Territory west from c. 134°E and in similar parts of the north-eastern Kimberley region of Western Australia.

There is probably intergradation with subsp. *grandifolia*, which is of similar aspect, around 134°E, and some collections from contact zones indicate a degree of intergradation with subsp. *lamprocardia* (Fig. 124). Such intergrades appear to represent the species on the Mitchell Plateau (a climatically wet area) at the western edge of the range of the subspecies (Fig. 124 and under subsp. *lamprocardia*). In the high-rainfall country of Bathurst and Melville Islands and the adjacent fringe of the Northern Territory mainland, particularly large-leaved forms occur, often with very long pedicels; these may show some cordate leaf-bases, perhaps indicating persistence of intermediate-phase foliage into the flowering stage; they differ from subsp. *lamprocardia* in leaf-lamina shape. By contrast, the scattered occurrences of the subspecies in the drier Wyndham region tend to approach (or simulate) the geographically distant subsp. *grandifolia* in having rather short petioles and pedicels.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

The epithet is from the Latin *longus*, long, alluding to the petioles, pedicels and fruits, which are longer than in subsp. *grandifolia*.

Selected specimens (from 11 examined): Western Australia: 11 km W of Durack River crossing on Wyndham to Gibb River road, *Hill 944A, Johnson & Benson*, 23 July 1984 (NSW); base of hill on track to Five Rivers Lookout, Wyndham, *Hill 4072 & Stanberg*, 14 Sep 1991 (NSW, CANB, PERTH); c. 11 km WSW of Kununurra, *Johnson 2054*, 25 Aug 1967.

Northern Territory: 5 miles [8 km] W of Bathurst Island mission, *Stevenson*, Jan 1974 (DNA 7277, CANB); 122.2 km from Maningrida to Ramingining road on Oenpelli road, *Hill 4011 & Stanberg*, 1 Sep 1991 (NSW, DNA); 8 miles [13 km] E of Mt Bundey mine, *Dunlop 1871*, 5 Sep 1970 (DNA, NSW); along the Ooloo [Oolloo] road, 16.5 km NE of Douglas River, *Tindale 6101 & Dunlop*, 12 July 1979 (NSW, CANB, K); 21 miles [33 km] NNW of 'Newry' station, *Perry 2974*, 12 July 1952 (CANB, NSW).

112C. ACUSSOP **Corymbia grandifolia** (R.Br. ex Benth.) *K.D. Hill & L.A.S. Johnson* subsp. **lamprocardia** *L.A.S. Johnson*, **subsp. nov.**

Inter subspecies C. *grandifoliae* combinatione characterum sequentium distinguitur: folia ramulique intermedii etiam aliquando adulti saepe persistenter aliquanto setoglandulosi; folia adulta late ovata vel deltoideo-ovata, saepissime plusminusve cordata vel basi non vel vix attenuata.

Type: Western Australia: Camel Creek, *K.D. Hill 3508 & L. Stanberg*, 29 Nov 1988 (holo NSW; iso DNA).

Tree to 15(–20?) m. *Intermediate leaves* and shoots with bristle-glands that usually persist to maturity, broad-ovate to suborbicular, usually more or less cordate. *Adult leaves* broad-ovate to deltoid-ovate with length:breadth ratio 2:1 (if up to 2.5:1 then deltoid), cordate or with lower edges spreading at a wide angle, sometimes ± setose; *petioles* 8–25 mm long. *Pedicels* (10–)12–30(–35) mm long. *Fruits* 12–17 mm long, 9–13 mm diam. Fig. 126.

Flowering: Sep–Dec.

Characterised among the subspecies by intermediate and sometimes also adult leaves (and associated branchlets) often bearing persistent bristle-glands, adult leaves ovate or deltoid-ovate, usually more or less cordate or with the base not or scarcely attenuate.

Locally abundant, usually on level and not 'hard' sites, in a broad belt south of subsp. *longa*, apparently with occasional overlap with that subspecies but not with subsp. *grandifolia* (Fig. 124). As mentioned under subsp. *longa*, there is some intergradation with subsp. *longa* in contact zones; also on and near the Mitchell Plateau, which has a higher rainfall than the area of subsp. *lamprocardia*, the populations are generally intermediate.

Conservation status: Locally abundant over a wide area, not considered to be at risk.

The epithet is from the Greek, *lampros*, shining, and *cardia*, a heart, referring to the characteristic crown of broad, glossy-green, cordate leaves.

Selected specimens (from 15 examined): Western Australia: 'Mt House' homestead to Mt House, *Johnson 2025*, 22 Aug 1967 (NSW); 15 miles [24 km] E of 'Carlton' station, *Perry 2658*, 29 July 1949 (CANB, NSW).

Northern Territory: 33 miles [53 km] by road from Katherine towards Willeroo, *Brooker 4183, 4184*, 19 Sep 1973 (CANB, NSW); 56 km W of Victoria River on dirt road detour, *Brooker 10967*, 12 Apr 1992 (CANB, DNA, NSW, PERTH); 45.1 miles [72 km] S of Katherine, *Chippendale NT 3880*, 5 Oct 1957 (DNA, NSW); 138.7 km W of Timber Creek, 5.3 km E of Keep River turnoff, *Hill 3358, Johnson & Stanberg*, 18 Nov 1988 (NSW, DNA).

Intergrades between the subspecies: Subsp. *lamprocardia* – subsp. *longa*.

Western Australia: Prospecting Camp, Mitchell River Plateau, *Johnson 2048*, 24 Aug 1967; headwaters of Lawley River, Mitchell Plateau, *Smith*, 16 Nov 1978 (PERTH, NSW 302079); 35.4 km S of Mitchell Plateau turnoff on Gibb River Road, *Hill 3413, Johnson & Stanberg*, 22 Nov 1988 (NSW).

Northern Territory: Plain to N of Wingate Mountains, *Hill 4055 & Stanberg*, 10 Sep 1991.

ACUT **Interserial hybridogenous species (Confertiflorae – Grandifoliae)**

113. ACUTTO **Corymbia paractia** *K.D. Hill & L.A.S. Johnson*, **sp. nov.**

Species characteribus inter eis *C. dendromeringis* et *C. flavescentis* distinguitur: folia intermedia late ovata cordataque, setosa setoglandulis trichomata brevia ferentibus; folia adulta subnitentia, lanceolata vel late lanceolata; pedunculi breves mediocresve; pedicelli mediocres ad longiusculi.

Type: Western Australia: growing naturally in remnant vegetation in grounds of city council nursery, Broome, *K. Hill 978, L. Johnson & D. Benson*, 31 July 1984 (holo NSW).

Tree, often several-stemmed, to 12 m. *Bark* smooth, white, shedding in thin scales, which are often patchily adherent on lower trunk. *Intermediate leaves* opposite, setose with bristle-glands bearing simple hairs, becoming ± bristle-free, broad-lanceolate to elliptical, rounded to obtuse, cordate in earlier stages, to 13 cm long, to 70 mm wide; *petioles* 8–12 mm long. *Adult leaves* disjunct, bristle-free, amphistomatic and concolorous, lanceolate to broad-lanceolate, acuminate, 7–15 cm long, 10–25 mm wide; *petioles* 4–10 mm long; *oil glands* obscured. *Inflorescences* at flowering borne laterally on leafless lengths of branchlets, moderately condensed; *umbellasters* to 7-flowered; *peduncles* 2–10 mm long; *pedicels* 5–15 mm long; intermediate internodes 1 or few, 0–3 mm long; basal internode 2–4 mm long. *Mature buds* pyriform, 4–5 mm long, 3–4 mm diam.; *calyptra* 1/4–1/3 as long as hypanthium, hemispherical, apiculate. *Fruits* ovoid, 9–11 mm long, 7–9 mm diam. Fig. 127.

Flowering: Oct–Dec.

Distinguished by the combination: intermediate leaves broadly ovate and cordate, with bristle-glands bearing short, simple trichomes; adult leaves slightly glossy, lanceolate to broad-lanceolate; peduncles short; pedicels longish.

Known only from a small area on the west coast of the southern part of the Dampier Peninsula, around Broome (Fig. 128). Locally abundant in dry monsoon savannah shrubland dominated by *Acacia* species. This species is restricted to a narrow strip where coastal beach dunes merge into the sandy red earths of the Pindan.

C. paractia is known from a limited area near and for a few kilometres north from Broome, from which *C. dendromerinx* (series *Confertiflorae*) and *C. flavescens* (series *Grandifoliae*) are both absent (K. Kenneally, pers. comm.), although the former occurs to the north-east and east (Fig. 107), and the latter to the north-east and south-west (Fig. 124). The populations of *C. paractia* exhibit some variation in the presence or amount of intermediate-phase foliage, occurring as reversion-shoots, in the crown, and in length of inflorescence internodes. They are nevertheless generally consistent morphologically as well as in habit and habitat, and are usefully regarded as a stabilised hybridogenous species, continuing in existence probably without further input from either *C. dendromerinx* or *C. flavescens*, in contrast to occasional individual hybrids between those species found where they co-occur (see under those species and Appendix 1).

Characters in which *C. paractia* is intermediate between those species of otherwise well-distinguished series include: the thinly flaky irregularly tessellated and irregularly partially persistent bark, shape and degree of glossiness of the intermediate and adult leaves, presence on intermediate growth of bristle-glands bearing simple lateral trichomes (approaching those of *C. dendromerinx*), nature of the conspicuous pointed leaf-buds as in series *Grandifoliae* generally, branching and dimensions (including thickness of parts) of the inflorescence.

This complex of characters does not support involvement of the parapatric or partly sympatric *C. bella* in the ancestry, nor does it agree with the features of series

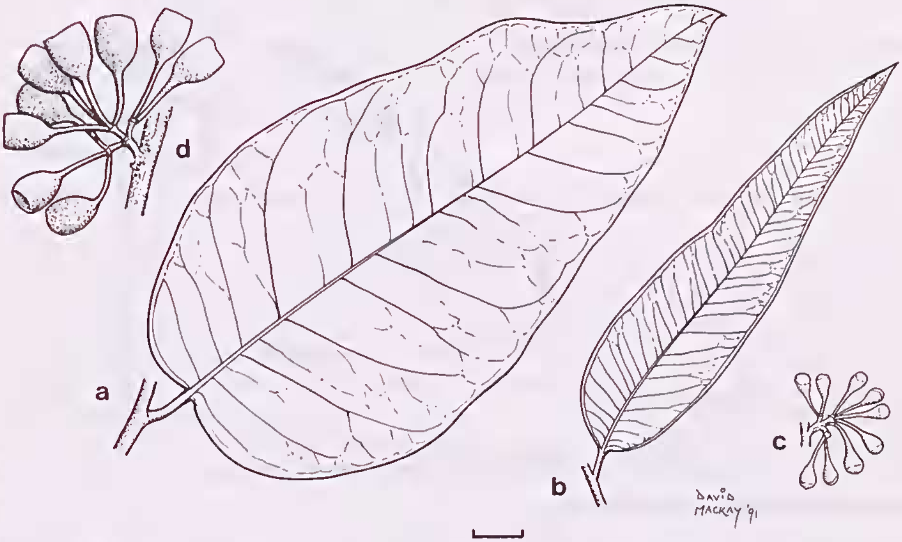

Fig. 127. *C. paractia* a, intermediate leaf. b, adult leaf. c, inflorescence and buds. d, inflorescence and fruits (a, d from *Hill 978 et al.*, b, c from *Brooker 10110*). Scale bar = 1 cm.

Polysciadae (where leaf-shape can be somewhat similar), the members of which, moreover, occur on quite different substrates from that of *C. paractia*.

The epithet is from the Greek *paraktios*, on the seaside, in reference to the beach-dune habitat.

Conservation status: Of limited distribution and potentially under threat from coastal tourist developments. 2K.

Selected specimens (from 12 examined): Western Australia: 6 miles [c.10 km] NNE of Broome township, *Lazarides 6581*, 25 Sep 1959 (CANB, NSW); 6 km N of Broome P.O., *Brooker 10110*, 18 Oct 1988 (CANB, NSW); Station Hill, Cable Beach, Broome, *Kenneally 11353*, 1 Dec 1992 (PERTH, NSW); 1 km E of racecourse, Broome, *Brooker 10107*, 17 Oct 1988 (CANB, NSW); Forest Dept office, Broome, *Willing 112, 113*, 29 Oct 1983 (PERTH).

shrubland dominated by *Acacia* species. This species is restricted to a narrow strip where coastal beach dunes merge into the sandy red earths of the Pindan.

C. paractia is known from a limited area near and for a few kilometres north from Broome, from which *C. dendromerinx* (series *Confertiflorae*) and *C. flavescens* (series *Grandifoliae*) are both absent (K. Kenneally, pers. comm.), although the former occurs to the north-east and east (Fig. 107), and the latter to the north-east and south-west (Fig. 124). The populations of *C. paractia* exhibit some variation in the presence or amount of intermediate-phase foliage, occurring as reversion-shoots, in the crown, and in length of inflorescence internodes. They are nevertheless generally consistent morphologically as well as in habit and habitat, and are usefully regarded as a stabilised hybridogenous species, continuing in existence probably without further input from either *C. dendromerinx* or *C. flavescens*, in contrast to occasional individual hybrids between those species found where they co-occur (see under those species and Appendix 1).

Characters in which *C. paractia* is intermediate between those species of otherwise well-distinguished series include: the thinly flaky irregularly tessellated and irregularly partially persistent bark, shape and degree of glossiness of the intermediate and adult leaves, presence on intermediate growth of bristle-glands bearing simple

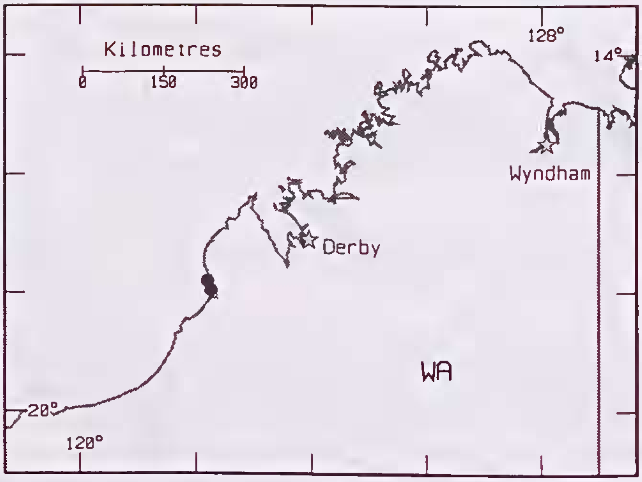

Fig. 128. Distribution of *C. paractia*.

lateral trichomes (approaching those of *C. dendromerinx*), nature of the conspicuous pointed leaf-buds as in series *Grandifoliae* generally, branching and dimensions (including thickness of parts) of the inflorescence.

This complex of characters does not support involvement of the parapatric or partly sympatric *C. bella* in the ancestry, nor does it agree with the features of series *Polysciadae* (where leaf-shape can be somewhat similar), the members of which, moreover, occur on quite different substrates from that of *C. paractia*.

The epithet is from the Greek *paraktios*, on the seaside, in reference to the beach-dune habitat.

Conservation status: Of limited distribution and potentially under threat from coastal tourist developments. 2K.

Selected specimens (from 12 examined): Western Australia: 6 miles [c.10 km] NNE of Broome township, *Lazarides 6581*, 25 Sep 1959 (CANB, NSW); 6 km N of Broome P.O., *Brooker 10110*, 18 Oct 1988 (CANB, NSW); Station Hill, Cable Beach, Broome, *Kenneally 11353*, 1 Dec 1992 (PERTH, NSW); 1 km E of racecourse, Broome, *Brooker 10107*, 17 Oct 1988 (CANB, NSW); Forest Dept office, Broome, *Willing 112, 113*, 29 Oct 1983 (PERTH).

Excluded names

E. calophylla Lindl. var. *hawkeyi* Blakely, Key Eucalypts: 85 (1934).

[= *Corymbia calophylla* x *C. ficifolia*]

Type citation: None cited.

Type: New South Wales: cultivated, Government House border, between nursery and main gates, *W.F. Blakely*, 2 Jan 1925 (lecto NSW 302775, here designated). The type is a hybrid of *C. calophylla* and *C. ficifolia* (see Appendix 1).

E. coniophloia D.J. Carr & S.G.M. Carr, Eucalyptus 1: 97 (1985).

[= *C. capricornia* – *C. drysdalensis* intergrade]

Type citation: 'Typus: *R.A. Perry 2867*, 3 June 1952, 33.6 km S. of Coolibah Station, N.T. 15°47' 130°57'. Holo. (AD 96827417).'

Many of the specimens cited by the above authors under *C. coniophloia* belong to *C. capricornia*. The type has the characters of an intergrade between *C. capricornia* and *C. drysdalensis* (q.v.), and is from a locality where such occur (see Appendix 1).

E. lamprocalyx Blakely, Key Eucalypts: 323 (1934).

[= *C. cadophora* x *C. polycarpa*]

Type citation: 'W.A.– Near Meda, West Kimberley. W.V. Fitzgerald, No. 416, April, 1905.'

This was regarded as a hybrid between *E. perfoliata* [≡ *C. cadophora* of the present work] and *E. collina* by Pryor and Johnson (1971). Carr and Carr (1987) correctly noted that *E. collina* does not occur in the area from which the type of *E. lamprocalyx* was collected, but went on to assert that the specimen was actually *E. perfoliata* with so-called fully developed adult leaves. If that were the case the name would replace the illegitimate *E. perfoliata*. Our detailed studies on specimens and in the field indicate, however, that trees of *C. cadophora* do not develop beyond the connate-leaved stage (discussed under *C. cadophora*). Occasional hybrid individuals have been collected on several occasions from the south-western Kimberley region (the type area for *E. lamprocalyx*), around Derby and north and east of there. These occur in or near stands of *C. cadophora* which, as elsewhere, show no sign of so-called 'adult-leaf' development, and *C. polycarpa* is nearby in each case. These hybrid individuals are intermediate in all observed characters between *C. cadophora* and *C. polycarpa*. The specimen cited below (Appendix 1) was from a single individual growing midway between stands of the two parent species. This specimen is morphologically intermediate, and showed low seed fertility, as may be expected in a hybrid between two rather distantly related species. It is also morphologically identical with the type of *E. lamprocalyx*, and we are now accepting the type specimen of the latter as being from a similar hybrid individual.

E. nowraensis Maiden, Crit. Rev. Eucalyptus 7: 68, 1924.

[= *C. gummifera* x *C. maculata*]

Type citation: 'The type is that of Mr. Alexander Joseph Gallagher, who collected it 4 miles east of Nowra.' Maiden later (same page) stated 'Mr. Gallagher's specimens were collected (1921) 4 miles east of Nowra, and 2 miles south of that town', and later (p. 80) 'Parish of Nowra, 2 miles south of Nowra, New South Wales. (Forest Guard A. J. Gallagher.) The type.'

Type: New South Wales: 2 miles [c. 3.2 km] S of Nowra, *A.J. Gallagher*, 2 July 1921 (holo NSW 304074). Although Maiden's words were '4 miles east of Nowra', there are no sheets bearing that locality, and this specimen corresponds to his later mention of a type. The above specimen matches the protologue, and is the only one with the appropriate date of a series collected by Gallagher from south of Nowra.

Hybrids between *C. gummifera* and *C. maculata* are known from the south coast of New South Wales, and the type of *E. nowraensis* is from one such individual (see Appendix 1). Recent claims that *E. nowraensis* is not a hybrid but a viable self-sustaining species (Carr & Carr 1987) cannot be substantiated. All organs are intermediate in morphology between those of the two parent species, and the seeds are particularly significant in this respect (Maiden, Crit. Rev. Eucalyptus 7: 109–110, 1924, and see *de Beuzeville 541*, cited below). The intrusive mesophyll fibres are also intermediate in abundance and form (Carr et al. 1971), and the bark combines the enlarged fibres of *C. gummifera* with the expanded phloem parenchyma of *C. maculata* (Chattaway 1955), a combination not recorded elsewhere in the bloodwoods. Its occurence is as occasional individuals where *C. gummifera* and *C. maculata* come into contact.

E. tokwa D.J. Carr & S.G.M. Carr, Eucalyptus 2: 152 (1987).

[= *C. latifolia* x *C. novoguinensis*]

Type citation: 'Typus: *D.J. Carr* 1872 13 June 1973, c.6 km from Tokwa on old road from Morehead, Western District, Papua-New Guinea. (= *Carr, D.J.* and *Henty, E.* N.G.Flora 49692). holo FRI [now CANB]. iso LAE, NT, PERTH, BRI, K.'

The type of the name (*Carr 1872*) is clearly (from its characters and locality) a hybrid between *C. latifolia* and *C. novoguinensis*. See Appendix 1.

Specimens cited as *E. tokwa* by the above authors from various parts of mainland Australia, excluding northern Cape York Peninsula, belong to several other species in series *Dichromophloiae* subseries *Latifoliosae*.

E. urnularis D.J. Carr & S.G.M. Carr, Eucalyptus 1: 87 (1985).

[= *C. dichromophloia* x *C. latifolia*]

Type citation:'Typus: *P.N. Martensz and R. Schodde AE519*, 6.8 km NW El Sharana Mine, Pine Creek Road, 30°31' 132°32', 23 Jan. 1973. Holo. (NT), iso. (FRI).'

Type: Northern Territory: 4 m[iles] [6.8 km] NW El Sharana-Pine Ck road, *[P.N.] Martensz & [R.] Schodde AE519*, 23 Jan 1973 (holo DNA, iso CANB). The latitude of this locality is c. 13°31'S, not 30°31' as cited in the protologue.

The type collection (holo & iso) represents *C. dichromophloia* x *C. latifolia*, as indicated by leaf shape, details of leaf venation, consistent fruit size and shape and the collectors' note 'bark rusty flaky becoming smooth on laterals off-white'. Both parent species occur in this area. Other specimens cited in the protologue include material of *C. dichromophloia*.

Other excluded names: Some additional names (essentially horticultural) in varietal rank under *E. calophylla* and *E. ficifolia* listed in Australian Plant Name Index (Chapman 1991) are largely untypifiable and of no consequence in a rational taxonomic treatment. Those that can be typified or have had any currency are mentioned under the respective species or, if they apply to hybrids, in Appendix 1.

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Appendix 1. Intergrading populations and hybrids

Hybridism has been recognised as a frequent and widespread occurrence in the eucalypts (Pryor & Johnson 1971, 1981; Pryor 1976). Several classes of hybrid may be recognised, but these are reduced to two categories in the following listing. The categories and symbols below are explained in the section (1.11) on hybridism in the introduction.

For the cases classed as intergrades, one of us (LJ) suggests optional condensed-formula designations, all similarly constructed from the first one-and-a-half syllables and the second syllable (sometimes slightly consonantally augmented) of the relevant epithet, such as C. ig. 'apadall' for *C. aparrerinja* – *C. dallachiana* intergrades. The 'ig.' (for 'intergrade') is intended for use with the designations but the square brackets [] (used simply to set them apart in the following lists) are not. The designations are not formal botanical names, i.e. they are external to the International Code of Botanical Nomenclature, and may be constructed at will, in alphabetical order of the taxa concerned, in appropriate circumstances; they are *not* recommended for the many cases of occasional non-self-sustaining hybrids. Where it is desirable to refer, especially repeatedly, to populations or examples thereof, they will be more convenient than lengthy designations as intergrades, provided that the combination of names is given in full at its first occurrence. Condensed formulae have in fact long been used, though irregularly, by eucalypt workers, and at least some ecologists have indicated that they would be useful, for instance in repeated references to vegetation communities.

Intersectional hybrids

Note: It will be seen that, directly or indirectly, all sections of *Corymbia* except the unispecific *Fundoria* and *Apteria* are linked by these.

C. bloxsomei x *C. variegata* (*Ochraria* x *Politaria*)

Queensland: 20 miles [c. 34 km] S of Wandoan, *Speck 1974*, 27 Apr 1964; Ballon Forest Reserve, c. 50 km NNW of Jandowae, *Johnson*, 5 June 1959 (NSW 302282); Barakula, *McGillivray 339*, 25 Aug 1957 (NSW).

C. catenaria x *C. citriodora* (*Ochraria* x *Politaria*)

Queensland: 15 miles [c. 24 km] SE of Springsure, *Blaxell 965 & Johnson*, 29 Nov 1972 (NSW, BRI).

C. dallachiana x *C. dimorpha* (*Blakearia* x *Ochraria*)

Queensland: Fredericks Peak/The Pinnacles, *Cumming 12571*, 11 Dec 1993 (BRI, NSW).

C. gummifera x *C. maculata* (= *E. nowraensis*) (*Rufaria* x *Politaria*)

See excluded names for the type of *E. nowraensis*.

New South Wales: Nowra, *de Beuzeville 541*, 3 Aug 1932 (CANB, NSW); Nowra Creek, between suspension bridge and Yalwal road, Nowra, *Rodway 3580*, June 1924 (NSW); Bellbird Hill, 4 km N of Eden, *Nuunink & Sheils 370*, 8 Feb 1982 (NSW).

C. henryi x *C. torelliana* (*Politaria* x *Cadagaria*)

Queensland: Aberdare Colliery, Dinmore, Ipswich, *Bird AQ458326*, 15 Nov 1989 (BRI, CANB, NSW). [*C. henryi* is native, *C. torelliana* is cultivated, at this site.]

C. intermedia x *C. maculata* (*Rufaria* x *Politaria*)

New South Wales: Kiwarrak State Forest, near Purfleet, *McDonald*, 25 Aug 1955 (NSW).

C. tessellaris x *C. torelliana* (*Blakearia* x *Cadagaria*)

A notable intersectional hybrid, known from two individuals occurring SW of Cooktown, Queensland.

Queensland: Cultivated QRS arboretum, seed from hybrid tree near Rossville, *Hill 1150, Johnson & Blaxell*, 17 Aug 1984 (NSW).

C. variegata x *C. watsoniana* subsp. *watsoniana* (*Politaria* x *Ochraria*)

Queensland: Ballon Forest Reserve, c. 50 km NNW of Jandowae, *Johnson*, 4 June 1959 (NSW 302806).

Section Rufaria

C. abergiana x *C. lamprophylla* (*Abergianae* x *Rhodopes–Stockerianosae*)

Queensland: ca. 1 km from Hidden Valley towards Paluma, *Brooker 10204*, 19 May 1989 (CANB, BRI, DNA, MEL, NSW).

C. bleeseri x *C. nesophila* (*Collinae* x *Nesophilae*)

Western Australia: 41.1 miles [c. 67 km] by road from 'Doongan' gate towards Kalumburu, *Brooker 4268*, 2 Nov 1973 (CANB, NSW); 21.6 km along Mitchell Plateau track from Kalumburu road, *Brooker 10978*, 14 Apr 1992 (CANB, NSW).

C. brachycarpa x *C. plena* (*Rhodopes–Brachycarposae* x *Polycarpae*)

Queensland: 2 km S of Bowie homestead on road to Kyong, *Thompson BUC156 & Simon*, 2 Apr 1992 (BRI, CANB, NSW); 18 km SW of Mirtna homestead on road to Yarrowmere, *Thompson BUC164 & Simon*, 6 Apr 1992 (BRI, AD, CANB, DNA, NSW, PRE).

C. brachycarpa x *C. setosa* subsp. *pedicellaris* (*Rhodopes–Brachycarposae* x *Ferrugineae–Zygophyllosae*)

Queensland: 14.2 km N of highway near Lochnagar siding on track to Red Mountain, *Hill 3872 & Johnson*, 23 May 1991 (NSW, BRI, CANB).

C. byrnesii – *C. greeniana* [C. ig. 'byrnegreen'] (within *Dichromophloiae–Latifoliosae*)

Western Australia: 1.7 km S of Drysdale River crossing on Gibb River Road, *Hill 3416, Johnson & Stanberg*, 22 Nov 1988 (NSW); 79.8 km W of Durack River on Wyndham to Gibb River road, *Hill 3384, Johnson & Stanberg*, 19 Nov 1988 (NSW).

C. byrnesii x *C. nesophila* (*Dichromophloiae–Latifoliosae* x *Nesophilae*)

Western Australia: Mitchell Plateau, 350 km WNW of Kununurra, c. 200 metres N of lower Mitchell Falls, *Barnsley 1564*, 22 Aug 1989 (CBG [now CANB], NSW).

C. cadophora x *C. polycarpa* (= *E. lamprocalyx*) (*Ferrugineae–Cadophorosae* x *Polycarpae*)

See excluded names for the type of *E. lamprocalyx*.

Western Australia: 3 km SW of Pindan Bore, E of Derby, *Hill 974, Johnson & Benson*, 31 July 1984 (NSW).

C. calophylla x *C. ficifolia* (= *E. ficifolia* var. *alba* and var. *guilfoylei*, *E. calophylla* var. *rosea* and var. *hawkeyi*) (*Gummiferae* x *Ficifoliae*)

See excluded names.

Cultivated, the caretaker's cottage, Government House grounds, Sydney, *F. Clark*, 18 Dec 1923 (NSW 302776); cultivated, Kings Park, Perth, *Jackson*, 28 Feb 1913 (NSW 302785). Many other specimens from cultivated trees.

C. calophylla x *C. chlorolampra* (within *Gummiferae*)

Western Australia: Hill E of Mt Michaud, *Brooker 7643*, 21 Sep 1982 (CANB, NSW, PERTH); E foot of Mt Peron, *Brooker 7996*, 2 Mar 1983 (CANB, NSW, PERTH). Observed also by us at these localities.

C. capricornia – *C. drysdalensis* [C. ig. 'capridrys'] (= *E. coniophloia*) (within *Dichromophloiae–Dichromophloiosae*)

See excluded names for type of *C. coniophloia*.

Northern Territory: crest of hill to S of road, 5.4 km W of Timber Creek, *Hill 3353, Johnson & Stanberg*, 18 Nov 1988 (NSW, CANB, DNA); 4 miles [6.4 km] N of Victoria River crossing, *Dunlop 3154*, 12 Apr 1973 (DNA, ANU, BRI, CANB, K, L, MEL, NSW).

C. capricornia x *C. opaca* (*Dichromophloiae–Dichromophloiosae* x *Dichromophloiae–Terminalosae*)

Northern Territory: 4.9 miles [c. 8 km] N of Elliott, *Chippendale NT 3856 & Johnson*, 3 Oct 1957 (DNA, NSW); 13 miles [c. 22 km] SE of Elliott, *Swinbourne 730*, 27 Mar 1963 (DNA, NSW).

C. capricornia x *C. polycarpa* (*Dichromophloiae–Dichromophloiosae* x *Polycarpae*)

Northern Territory: 30 miles [48 km] E of Montejinni station, *Perry 2883*, 7 June 1952 (CANB, NSW).

C. capricornia – *C. umbonata* [C. ig. 'capriumb'] (within *Dichromophloiae–Dichromophloiosae*)

Northern Territory: 7.8 km N of Larrimah, *Hill 3272, Johnson & Stanberg*, 9 Nov 1988 (NSW); Larrimah, *Ralph*, 9 Sep 1973 (NSW 302470).

C. chippendalei x *C. eremaea* subsp. *eremaea* (within *Dichromophloiae–Terminalosae*)

Northern Territory: 131°48'S 24°53'E, *Dunlop 1889*, 19 Sep 1970 (DNA, NSW).

C. chippendalei x *C. opaca* (within *Dichromophloiae–Terminalosae*)

Northern Territory: 21.5 km W of Yulara on Mt Olga road, *Brooker 9447*, 1 Sep 1986 (CANB, NSW).

C. clarksoniana x *C. hylandii* subsp. *hylandii* (*Polycarpae* x *Rhodopes–Stockerianosae*)

Queensland: 3.7 km E of lower Normanby River crossing on Battle Camp road, *Hill 1942, Hind & Healey*, 3 Aug 1986 (NSW); 8.4 km E of lower Normanby River crossing on Battle Camp road, *Hill 1943, Hind & Healey*, 3 Aug 1986 (NSW); 8.4 km E of Normanby R crossing on Battle Camp rd, *Blaxell 89/155, Johnson & D'Aubert*, 2 Aug 1989 (NSW); 8.2 km E of Normanby R crossing on Battle Camp rd, *Blaxell 89/154, Johnson & D'Aubert*, 2 Aug 1989 (NSW).

C. clarksoniana – *C. novoguinensis* [C. ig. 'clarksonov'] (within *Polycarpae*)

Queensland: 500 metres W of Bolt Head (12°16'S 143°05'E), *Hill 1812, Hind & Healey*, 25 July 1986 (NSW); 34 km S of Dulhunty River on Peninsula Development Road, *Clarkson 5693*, 7 Nov 1984 (BRI, CANB, NSW, QRS); 23 km N of Moreton telegraph office, *Benson 588*, 6 Oct 1973 (NSW); 20 km S of Wenlock River on Peninsula Development Road, *Clarkson 5004*, 11 Aug 1983 (BRI, CANB, NSW, QRS); 47 km W of Peninsula Development Road on road to Weipa via Merluna, *Clarkson 5648*, 1 Nov 1984 (BRI, CANB, NSW, QRS); 1 mile [1.6 km] south of Portland Roads, *Stocker 868A*, 29 June 1972 (QRS, NSW).

C. curtipes – *C. foelscheana* [C. ig. 'curtifoelsch'] (within *Dichromophloiae–Latifoliosae*)

Northern Territory (from 12 examined): Dhalinbuy Road, Arnhem Land (12°24'S 136°37'E), *Clark 1525*, 30 Sep 1987 (DNA, NSW); Morgans [Morgan] I., [13°27'S

136°04'E], *R. Brown [Bennett 4779]*, 21 Jan 1903 (NSW ex BM); 102.8 km W of Katherine on Kununurra road, *Hill 3301, Johnson & Stanberg*, 11 Nov 1988 (NSW); 138.7 km W of Timber Creek (5.3 km E of Keep River turnoff), *Hill 3359, Johnson & Stanberg*, 18 Nov 1988 (NSW).

C. curtipes – C. greeniana [C. ig. 'curtigreen'] (within *Dichromophloiae–Latifoliosae*)

Northern Territory: near Cockatoo Springs, c. 25 miles [40 km] NW of Newry station, *Perry 2970*, 12 July 1952 (CANB, NSW).

C. curtipes x *C. opaca* (*Dichromophloiae–Latifoliosae* x *Dichromophloiae–Terminalosae*)

Northern Territory: 138.7 km W of Timber Creek (5.3 km E of Keep River turn-off) *Hill 3357, Johnson & Stanberg*, 18 Nov 1988 (NSW).

C. curtipes x *C. polycarpa* (*Dichromophloiae–Latifoliosae* x *Polycarpae*)

Western Australia: 21 miles [c. 37 km] from Kununurra towards Wyndham, *Brooker 4214*, 30 Oct 1973 (CANB, NSW).

C. curtipes x *C. terminalis* (*Dichromophloiae–Latifoliosae* x *Dichromophloiae–Terminalosae*)

Northern Territory: 15.5 km NE of Willeroo Junction (107.8 km SW of Katherine), *Hill 3343 Johnson & Stanberg*, 17 Nov 1988 (NSW); 7.9 km from Mainoru road on Gove road, *Hill 3906 & Stanberg*, 24 Aug 1991 (NSW, CANB, DNA).

C. curtipes x *C. umbonata* (*Dichromophloiae–Latifoliosae* x *Dichromophloiae–Dichromophloiosae*)

Northern Territory: 21 km SE of Katherine on Stuart Highway, *Blaxell 88/132 & Wrigley*, 26 July 1988 (NSW, DNA).

C. dampieri – C. greeniana [C. ig. 'dampigreen'] (within *Dichromophloiae–Latifoliosae*)

Western Australia: 20.8 km SW of Mt Hart turnoff on Gibb River Road, *Hill 3435, Johnson & Stanberg*, 23 Nov 1988 (NSW); 33.8 km ENE of Windjana turnoff on Gibb River Road, *Brooker 10131*, 20 Oct 1988 (CANB, NSW).

[*C. dampieri – C. opaca*: see ACIVRI *C. pedimontana* in main text]

C. dampieri x *C. polycarpa* (*Dichromophloiae–Latifoliosae* x *Polycarpae*)

Western Australia: Broome, *Ostenfeld 527*, 5 Nov 1914 (NSW); 5 km SE of Derby, *Brooker 10134*, 21 Oct 1988 (CANB, NSW).

C. deserticola subsp. *mesogeotica* x *C. eremaea* subsp. *oligocarpa* (*Ferrugineae–Deserticolosae* x *Dichromophloiae–Terminalosae*)

Northern Territory: Pulcacurrinya Waterhole (22°49'S 131°51'E), *Dunlop 2455*, 20 Jan 1972 (DNA, CANB, NSW).

C. dichromophloia x *C. latifolia* (= *E. urnularis*) (*Dichromophloiae–Dichromophloiosae* x *Dichromophloiae–Latifoliosae*)

See excluded names for the type of *E. urnularis*.

Northern Territory: Umbrawarra, *Jensen 410*, 5 July 1916 (NSW); near Edith River crossing, *Bateman*, 25 Oct 1950 (CANB, NSW).

C. dolichocarpa – C. maritima [C. ig. 'dolimar'] (within *Polycarpae*)

Queensland: 34.2 km from Ravenswood on Ayr road, *Hill 3710 & Stanberg*, 25 July 1990 (NSW, BRI, CANB); 22.2 km from Mingela on road to Burdekin Falls, *Hill 3706 & Stanberg*, 22 July 1990 (NSW, BRI, CANB); 26.0 km from Bruce Highway towards 'Cattle Vale', *Hill 3783 & Stanberg*, 6 Aug 1990 (NSW, BRI, CANB); near Dolly Creek, Middle Percy Island, *Batianoff 11612, Dillewaard, Champion & Thompson*, 29 Oct 1989 (BRI, CANB, NSW, PRE); 16.3 km from Bruce Highway at Glen Geddes towards Shoalwater, *Hill 3793 & Stanberg*, 7 Aug 1990 (NSW, BRI, CANB); just W of old homestead, Great Keppel Island, *Batianoff 9363 & Dillewaard*, 9 Nov 1987 (BRI, CANB, NSW).

C. dolichocarpa – C. plena [C. ig. 'doliplen'] (within *Polycarpae*)

Queensland: 2.7 km N of Tambo on Alpha road, *Hill 3882 & Johnson*, 24 May 1991 (NSW, BRI, CANB).

C. dolichocarpa x *C. tumescens* (*Polycarpae* x *Dichromophloiae–Terminalosae*)

Queensland: 23.4 km N of Wyandra on Cunnamulla to Charleville road, *Blaxell 879/002, Johnson & D'Aubert*, 22 July 1989 (NSW, BRI).

C. drysdalensis x *C. greeniana* (*Dichromophloiae–Dichromophloiosae* x *Dichromophloiae–Latifoliosae*)

Western Australia: Isdell Range, at E88, *Fitzgerald*, July 1905 (NSW 302442). Apparently this hybrid.

[*C. drysdalensis – C. opaca*: see ACIVJO *C. opacula* in main text]

C. drysdalensis – C. opacula [C. ig. 'drysdaop'] (involving *Dichromophloiae–Dichromophloiosae* and *Dichromophloiae–Terminalosae*)

Western Australia: 31.2 km S of Turkey Creek, *Hill 3489, Johnson & Stanberg*, 26 Nov 1988 (NSW); 15.5 km from highway on track to Bungle Bungle National Park, *Hill 3504, Johnson & Stanberg*, 28 Nov 1988 (NSW); 60 miles [100 km] N of Halls Creek, *Byrnes 2338*, 5 June 1971 (NSW).

C. drysdalensis x *C. polycarpa* (*Dichromophloiae–Dichromophloiosae* x *Polycarpae*)

Western Australia: Gorge to W of Silent Grove homestead, 17°04'S 125°14'E *Hill 3428, Johnson & Stanberg*, 23 Nov 1988 (NSW).

C. eremaea subsp. *eremaea – C. opaca* [C. ig. 'ereop ereop'] (within *Dichromophloiae–Terminalosae*)

South Australia: 300 miles [480 km] SW of Alice Springs and 1/4 mile [0.4 km] S of NT Border, *Turvey*, 10 Aug 1968 (NSW 311238).

Northern Territory: 137.5 km N of Kulgera, *Brooker 9439*, 30 Aug 1986 (CANB, NSW); c. 1 km S of Mt Conner, *Hill 3228 & Stanberg*, 6 Nov 1988 (NSW, CANB, NT).

Western Australia: 368 km NE of Cosmo Newbery [Cosmo Newberry] [on track to Warburton], *Brooker 8544*, 10 May 1984 (CANB, NSW); 53 km E of Warburton, *Brooker 9218*, 4 Apr 1986 (CANB, NSW).

C. eremaea subsp. *oligocarpa – C. opaca* [C. ig. 'ereop oliop'] (within *Dichromophloiae–Terminalosae*)

Northern Territory: between viewing point and Ellery Gorge, *Brooker 5092*, 1 Apr 1976 (CANB, NSW); Standley Chasm, *Forde 50*, 22 Dec 1955 (DNA, NSW); 2 miles [3.2 km] S of Heavitree Gap, Alice Springs, *Dunlop 2093*, 12 Mar 1971 (DNA, NSW); 10 miles [16 km] SE of Alice Springs, *Nelson 2263*, 13 Mar 1973 (DNA); 21.4 km from Ross River road towards Arltunga, *Hill 3241, Johnson & Stanberg*, 7 Nov 1988 (NSW).

C. erythrophloia – C. pocillum [C. ig. 'erypoc'] (within *Dichromophloiae–Dichromophloiosae*)

Queensland: 12 km W of Einasleigh on Forsayth road, *Benson 825*, 18 June 1974 (NSW); Chudleigh Park Station, southern Gregory Range on the upper Stawell River, *Hill 3737 & Stanberg*, 29 July 1990 (NSW, BRI).

C. foelscheana x *C. polycarpa* (*Dichromophloiae–Latifoliosae* x *Polycarpae*)

Northern Territory: Baroalba Creek, Pine Creek road, Kakadu National Park, *Boland 2187 & Wardman*, 20 Nov 1984 (CANB, NSW).

C. greeniana x *C. polycarpa* (*Dichromophloiae–Latifoliosae* x *Polycarpae*)

Western Australia: 16.0 km W of Bindoola Creek on Wyndham to Gibb River road, *Hill 3363, Johnson & Stanberg*, 19 Nov 1988 (NSW).

C. hamersleyana – *C. semiclara* [C. ig. 'hamesem'] (within *Dichromophloiae–Terminalosae*)

Western Australia: 12.1 km [not 121 km] N of Marble Bar (2 km N of Coongan River Crossing), *Kenneally 7676*, 27 June 1981 (PERTH, NSW); near Marble Bar airport, *Johnson 2119*, 27 Aug 1967 (NSW); 1.5 km along the Tom Price road from Wittenoom turnoff, *Brooker 10732*, 17 Apr 1991 (CANB, MEL, NSW, PERTH); 11.2 km W of Packsaddle Camp, 22°52'S 118°43'E, *Johnson 9310 & Briggs*, 30 July 1991 (NSW, CANB, PERTH); 40 km E of Newman to Nullagine road on Jiggalong road, *Pryor*, 20 Aug 1985 (NSW); S of Rudall River, *George 10750*, 20 May 1971 (PERTH, NSW); 50.6 km N of Kumarina, *Brooker 10727, 107228*, 15 Apr 1991 (CANB, NSW, PERTH).

C. latifolia x *C. novoguinensis* (= *E. tokwa*) (*Dichromophloiae–Latifoliosae* x *Polycarpae*)

Papua New Guinea: *Carr 1872*, cited above under excluded names.

C. latifolia x *C. oocarpa* (*Dichromophloiae–Latifoliosae* x *Dichromophloiae–Oocarposae*)

Northern Territory: 17 km S of Jim Jim road on Pine Creek road, *Johnson 8155*, 24 Sep 1975 (NSW, CANB, DNA); 19.7 km from Katherine towards Katherine Gorge, *Hill 3308, Johnson & Stanberg*, 12 Nov 1988 (NSW).

C. lenziana – *C. opaca* [C. ig. 'lenziop'] (within *Dichromophloiae–Terminalosae*)

Western Australia: 29.8 km W of Carnegie, *Brooker 10715*, 15 Apr 1991 (CANB, NSW, PERTH); ca. 100 km E of Carnegie on Gunbarrel Hwy, *Brooker 10711*, 15 Apr 1991 (CANB, DNA, NSW, PERTH).

C. novoguinensis – *C. polycarpa* [C. ig. 'novopol'] (within *Polycarpae*)

Queensland: 15.3 km from Weipa to Mapoon road on track to mouth of Pennefather River, *Clarkson 4930*, 6 Aug 1983 (BRI, CANB, NSW, QRS); Nutwood Crossing of the Edward River (14°40'S 141°30'E); *Clarkson 3520*, 11 Oct 1980 (BRI, CANB, NSW); ca. 0.5 km from Magnificent Creek crossing, Kowanyama, *Clarkson 3349*, 14 Aug 1980 (BRI, CANB, NSW, QRS).

C. opaca – *C. terminalis* [C. ig. 'opaterm'] (within *Dichromophloiae–Terminalosae*)

Northern Territory: 47 miles [85 km] E of Three Way Road House, on Barkly Hwy, *Nicholls 584*, 30 June 1967 (DNA, NSW); 25.4 miles [c. 41 km] W of Soudan HS, *Chippendale NT 3838 & Johnson*, 2 Oct 1957 (DNA, NSW); 58.3 km SW of East Baines, on Victoria Hwy, *Tindale 10127, Munns & Turley*, 3 Aug 1989 (NSW, BRI, DNA, K); 25 miles [40 km] SSE Victoria River Downs station, *Perry 2143*, 12 June 1949 (CANB, NSW); 22.4 km E of Wave Hill store, *Hill 3537 & Stanberg*, 30 Nov 1988 (NSW).

C. plena x *C. terminalis* (*Polycarpae* x *Dichromophloiae–Terminalosae*)

Queensland: Chudleigh Park Station, southern Gregory Range on the upper Stawell River, *Hill 3736 & Stanberg*, 29 July 1990 (NSW, BRI, CANB).

C. pocillum x *C. polycarpa* (*Dichromophloiae–Dichromophloiosae* x *Polycarpae*)

Queensland: Croydon, *Gill 3*, 20 Nov 1911 (NSW).

C. polycarpa x *C. ptychocarpa* subsp. *aptycha* (*Polycarpae* x *Ptychocarpae*)

Northern Territory: El Sharana road, 69 km from Pine Creek, *G. Brown*, 11 Apr 1977 (DNA, CANB, NSW 306745); UDP mine area, *Dunlop & Byrnes 2126*, 17 Mar 1971 (DNA, NSW).

C. polycarpa x *C. terminalis* (*Polycarpae* X *Dichromophloiae–Terminalosae*)

Northern Territory: 48 km S of Larrimah, *Fox*, June 1983 (NSW 306744).

C. terminalis – *C. tumescens* [C. ig. 'termitum'] (within *Dichromophloiae–Terminalosae*)

Queensland: 38 miles [61 km] W of Cloncurry, *Beadle*, 9 Sep 1972 (NSW 313693); SE of Cloncurry, *Bateman 11384*, 29 Aug 1962 (NSW); Carandotta south-east of Urandangie, *Blake 10169*, 13 Feb 1935 (NSW); 25.1 km from Longreach on Winton road, *Hill 3864 & Johnson*, 23 May 1991 (NSW, BRI, CANB); 30 km E of Barcaldine, *Brooker 10437*, 10 Mar 1990 (CANB, BRI, CANB, DNA, MEL, NSW); 22 km from Blackall on Barcaldine road, *Hill 1747, Hind & Healey*, 18 July 1986 (NSW, BRI, CANB, PERTH).

Section **Ochraria**

C. catenaria – *C. watsoniana* subsp. *capillata* [C. ig. 'catewats catecap']

Queensland: W of Coynes Bore [latitude is 24°37', not 25°37' as on label], *Brooker 10447*, 12 Mar 1990 (CANB, BRI, MEL, NSW, QRS); c. 5.5 km W of Coynes Bore, *Martensz 1084*, 26 Aug 1976 (CANB, NSW).

C. dimorpha x *C. leichhardtii*

Queensland: 7 miles [12 km] NW of Cerito Station [21°08'S 147°21'E], *Adams 972*, 21 May 1974 (CANB, NSW).

C. dimorpha x *C. peltata*

Queensland: 12 miles [20 km] W of Conjuboy towards Hughenden, *Brooker 4139*, 26 Aug 1973 (CANB ex FRI, NSW).

C. leichhardtii – *C. peltata*. See discussion under ACOYYQ *C. dimorpha*, especially concerning some specimens outside the main distribution of that species.

[*C. leichhardtii* – *C. watsoniana*. See ACOYYN *C. catenaria* in main text.]

Section **Politaria**

C. citriodora – *C. variegata* [C. ig. 'citrivar']

Queensland: c. 5 km N of Kalpowar on Calliope to Monto road, *K. Wilson 3743 & Sharpe*, 6 May 1981 (NSW, BRI, CANB); Goodnight Scrub, c. 65 km SW of Bundaberg, *Smith 9804*, 11 June 1957 (BRI, NSW); Isis River, 6.9 miles [c. 12 km] E of Childers, *Chippendale 545 & Johnston*, 7 June 1968 (CANB, NSW).

C. maculata – *C. variegata* [C. ig. 'macuvar']

New South Wales: Andersons Sugarloaf, Macleay River, *Boorman*, Aug 1909 (NSW 302647); 9.1 km by road WNW of West Kempsey, then 0.3 km N on John Lane Rd, *Johnson 9243*, 6 Jan 1993 (NSW, 13 sheets).

C. henryi x *C. variegata*? No specimens but probable examples have been observed in the field in areas of contact in SE Queensland and NE New South Wales.

Section **Blakearia**

Intergrades are frequent in this section (see under sect. *Blakearia* (ACU) in 2. Taxonomy) and there are some occasional individual hybrids also. Specimens from significant occurrences are cited below.

C. aparrerinja x *C. blakei* subsp. *blakei* – subsp. *rasilis* intergrade (*Grandifoliae* x *Gilbertenses*)

Queensland: 18.3 km NE of Jundah on Longreach road, *Hill 3847 & Johnson*, 22 May 1991 (NSW, BRI, CANB).

C. aparrerinja x *C. candida* subsp. *dipsodes* (*Grandifoliae* x *Asperae*)

Northern Territory: 15 km SE of Lake Surprise, *Latz 10062*, 26 June 1985 (DNA, NSW).

C. aparrerinja – *C. dallachiana* [C. ig. 'apadall'] (within *Grandifoliae*)

Queensland: 50 km E of Barcaldine, *Brooker 7862*, 7 Dec 1982 (CANB, BRI, NSW).

C. aparrerinja – *C. flavescens* [C. ig. 'apaflav'] (within *Grandifoliae*)

Queensland: 4 miles [6 km] S of Morstone, *Perry 1041*, 28 May 1948 (CANB, BRI).

C. arafurica – *C. bella* [C. ig. 'arabell'] (within *Papuanae*)

Northern Territory: NE of junction of Margaret River with Adelaide River, *Blake 16992*, 13 Sep 1946 (BRI, NSW); 'Stapleton' Station, *G. Hill 311*, 23 Dec 1912 (NSW).

C. arafurica x *C. polysciada* (*Papuanae* x *Polysciadae*)

Northern Territory: Kapalga, *Maconochie 2551*, 16 Oct 1980 (DNA, NSW).

C. bella x *C. confertiflora* (*Papuanae* x *Confertiflorae*)

Northern Territory: c. 5 miles [c. 8 km] NW of Katherine, *Adams 949*, 10 Apr 1964; 12.4 km NE of Willeroo Junction, *Hill, Johnson & Stanberg*, 17 Nov 1988 (NSW).

C. bella x *C. grandifolia* subsp. *grandifolia* (*Papuanae* x *Grandifoliae*)

Queensland: 32 miles [51 km] E of Croydon, *Johnson & Pryor*, Oct 1964 (NSW 312424).

C. bella – *C. paracolpica* [C. ig. 'bellapar'] (within *Papuanae*)

Queensland: 6.3 km from Rokeby on Merapah road, *Hill 4718 & Stanberg*, 14 July 1994 (NSW); Edward River Mission, *Johnson 7815*, 20 Aug 1974 (NSW).

C. blakei subsp. *rasilis* x *C. tessellaris* (*Gilbertenses* x *Tessellares*)

Queensland: probable occurrence 104 km west of Charleville on Quilpie road seen by Hill & Johnson in May 1991 but no specimens collected.

C. candida subsp. *dipsodes* x *C. ferriticola* subsp. *ferriticola* (within *Asperae*)

Western Australia: 82.1 km W of Newman on track to Tom Price via Mt Meharry, *Hill 487, Johnson, Blaxell, Brooker & Edgecombe*, 1 Nov 1983; 18 miles [c. 30 km] N [NE] of Meekatharra, *Speck 1084*, [c. 1959] (CANB, NSW).

C. candida subsp. *lautifolia* x *C. flavescens* (*Asperae* x *Grandifoliae*)

Western Australia: 63 km from Marble Bar garage towards Nullagine, *Brooker 11006*, 21 Apr 1992 (CANB, NSW, PERTH) [this may represent a population rather than an isolated hybrid, but the field notes are not informative on this point].

C. chillagoensis x *C. confertiflora* (*Gilbertenses* x *Confertiflorae*)

Queensland: Granite hills E of Peninsula road between 1st and 2nd crossings of Reedy St George Creek, *Stocker 932*, 23 Aug 1972 (QRS, NSW). Apparently this hybrid.

C. confertiflora – *C. disjuncta* [C. ig. 'confedis'] (within *Confertiflorae*)

Queensland: On shortcut between Weipa and Iron Range roads at 13°13'S, 142°51'E, *Hill 4717 & Stanberg*, 14 July 1994 (NSW).

Northern Territory: 10.3 km E of Flying Fox Creek crossing, *Hill 3902 & Stanberg*, 24 Aug 1991 (NSW).

C. confertiflora x *C. tessellaris* (*Confertiflorae* x *Tessellares*)

Queensland: Mt Babinda, *Stephens NQNC 11841*, 25 Oct 1947 (BRI).

C. dallachiana x *C. gilbertensis* (*Grandifoliae* x *Gilbertenses*)

Queensland: 8 km N of Galah Creek (20°35'S), *Hyland 6147*, 19 May 1972 (NSW).

C. dallachiana – *C. grandifolia* subsp. *grandifolia* [C. ig. 'dallagrand dallagrand'] (within *Grandifoliae*)

Queensland: Aurora Creek, Georgetown, *Hyland 5104*, 3 June 1971 (NSW).

C. dendromerinx x *C. flavescens* (see also ACUTTO *C. paractia*, hybridogenous species) (*Confertiflorae* x *Grandifoliae*)

Western Australia: Meda, May River, *Fitzgerald 382*, Apr. 1905 (NSW); 100 km ENE of Broome P.O. on Derby Road, *Brooker 10117*, 19 Oct. 1988 (CANB, NSW). These occurrences appear to represent occasional hybrids rather than the stabilised populations of *C. paractia*.

C. disjuncta x *C. papuana* (*Confertiflorae* x *Papuanae*) This could in part be regarded as an extensive intergrade C. ig. 'disjupap', especially east of Port Moresby; for instance there are specimens in BRI (not recorded) from the Tavai Creek area or thereabouts.

Papua New Guinea: Port Moresby, *White 79*, July-Aug 1918 (BRI, NSW).

C. disjuncta – *C. pauciseta* [C. ig. 'disjupauc'] (within *Confertiflorae*)

Northern Territory: Elcho Island at 11°58'S, 135°37'E, *Dunlop 3854* (DNA).

C. disjuncta x *C. polysciada* (*Confertiflorae* x *Polysciadae*)

Northern Territory (from 3 seen): 50.6 km from Labelle Downs on track to Channel Point, *Hill 4039 & Stanberg*, 8 Sep 1991 (NSW).

C. flavescens – *C. grandifolia* subsp. *grandifolia* [C. ig. 'flavegrand flavegrand'] (within *Grandifoliae*)

Queensland: 28.8 km from Gregory Downs towards Lawn Hill, *Hill 3572A & Stanberg*, 4 Dec 1988 (NSW); Gilbert River flats, *Hyland 5110*, 3 June 1971 (QRS, NSW); Cumberland, Gilbert River, *Brass 8858*, May 1937 (BRI).

C. paracolpica x *C. tessellaris* (*Papuanae* x *Tessellares*) (interserial hybrids or hybrid swarms — see main text)

Queensland: Cape York, *Clarkson 5673, 5674*, 5 Nov 1984 (BRI, NSW); 2 km from Musgrave-Marina Plains road towards Dinner Creek, *Hill 1916, Hind & Healey*, 1 Aug 1986; Morehead River crossing on the track west of Breeza Plains to Pelican Lagoon, *Clarkson 5018*, (BRI, NSW, QRS).

Appendix 2. Phylogenetic analyses

App. 2 (a). General

It is now widely accepted in systematics that systems of classification should reflect phylogeny, as far as this can be strongly hypothesised, and that systems that demonstrably do not reflect phylogeny should be abandoned. While these principles are logical and unambiguous, the complexity of evolution and the consequent difficulties in definition of homology (the equivalence of characters derived by common descent within a monophyletic group) has meant that elucidation of phylogenetic relationships is at times extremely difficult. A cladogram (and, more explicitly, a phylogram) hence must be regarded as a hypothesis of phylogeny, subject to corroboration or falsification in the light of additional data or a better understanding of homologies.

The principle of parsimony (in a rather simplistic interpretation) has been widely (but not universally) adopted as a basis for cladogram derivation, at least in phenotypic ('morphological') cladistics, in preference to a range of alternative procedures. Briefly, this involves choosing hypotheses of phylogeny that supposedly minimise the requirements for ad hoc invocation of parallel and convergent evolution (homoplasy). Reservations expressed by one of us (Johnson 1989; Johnson & Briggs 1984) about the uncritical use of 'parsimony' are maintained, especially as to the lack of equivalence or commensurability of character-state changes where different characters are concerned. However, these do not destroy the robustness of conclusions regarding the *Angophora* + *Corymbia* clade and its distinctness from the remainder of the eucalypts.

Phylogenetic analyses for this study were generated using PAUP version 3.1.1 (Swofford 1993). The characters were coded as in the next section (App. 2 (b). Enumeration and discussion of characters) with an initial assignment of polarity using the non-eucalypt Myrtaceae in general as outgroup. The *Arillastrum* group (= *Eucalyptopsis* Alliance of Johnson & Briggs, 1984) was taken as an outgroup by Ladiges and Humphries (1983), on the prevalent and curious assumption made by many cladists that an outgroup must be some particular (putatively) related group of this kind, rather than using the most general (not necessarily the most common in terms of the number of formal taxa showing it) condition in related groups. The *Arillastrum* group in fact itself shows a few apomorphies *either* parallel to some in the *Angophora* + *Corymbia* + non-bloodwood eucalypt assemblage *or* actually constituting synapomorphies with part of that assemblage (see 1.5 and 1.6 in main text, and figures 1 and 2). The outgroup is therefore taken as the 'ancestor' of Tables 1–4, having a zero score for every character and based on general conditions in the Myrtales and Myrtaceae. The *Arillastrum* group is itself included in the analyses where appropriate.

Tables 1a, 1b, 2 and 3 present the character-state scores, respectively, for the analyses covering (1) the *Arillastrum* + 'eucalypt' (including *Angophora*) group as a whole, (2) the *Angophora* + *Corymbia* group, and (3) the augmented red-bloodwood set in more detail. All scores are in binary form.

Phylograms and cladograms relevant to the discussion and conclusions in sections 1.5 and 1.6 of the main text are shown, with necessary explanations, in figures 1–5.

Careful consideration of character-state definition, involving re-scoring in some cases, has resulted in increase in the resolution of trees generated and in fewer trees (in one case reduced from >680 to 3). In all cases characters were treated as unordered (reversible) in the first place, but (except for set (2)) this produced trees containing a number of reversals, for instance in 'fusion' of perianth parts, that we consider highly unlikely as actual evolutionary reversions, for developmental and adaptational reasons. This objection to reversals does not apply, of course, to neotenic reversions, which have already been covered individually (see below, App. 2 (b)). Accordingly, the matrices were reprocessed, using PAUP options, with irreversibility imposed on some (or for convenience, when there would obviously be no effect on polarity, on all) characters. Some consequent increase in tree-length is not regarded as outweighing greater believability; that is, in effect, greater parsimony (≡ not invoking unnecessary hypotheses) in the broader framework.

App. 2 (b). Enumeration and discussion of characters

Many of the characters used here were also used (though sometimes modified or differently interpreted) in earlier cladistic or phylogenetic analyses (Ladiges & Humphries 1983 and/or Johnson & Briggs 1984). Such characters are annotated below with L&H for the former and J&B for the latter, followed by the number of the character in the respective data set. Characters used in more detailed analyses within the *Angophora* + *Corymbia* clade are more fully discussed in the main text (1.9). Parenthesised numbers following the character number refer to the data set in which the character is used (1 = eucalypt set, 2 = *Angophora* + *Corymbia* set, 3 = augmented red-bloodwood set). Some characters used in our earlier analyses are retained in the numbering system (for convenience and to indicate them as significant synapomorphies for the constituents of taxa in which they occur) although they have been eliminated from the present analyses as autapomorphies for the taxa as scored or occasionally because of inconstancy; such cases are shown hereunder in square brackets []. The data matrices used for processing are given in Tables 1 to 3.

[1(2). 0 = cotyledons at least partly folded / 1 = cotyledons flat (J&B 64, L&H 16). Flat cotyledons are probably plesiomorphic in the Myrtaceae, and occur in *Blakearia* and purportedly in *Angophora*. Within the *Arillastrum* + eucalypt clade, however, at least partial folding appears to be basic, as it is in such genera as *Lindsayomyrtus* (closer study of seedlings in fact suggests that some *Angophora* cotyledons are partially folded). The character, as here defined, is an autapomorphy for *Blakearia*, so it is omitted from the analysis.]

2(1). 0 = adult leaves with few lateral veins / 1 = adult leaves with many lateral veins (J&B 24, L&H 22). Proliferation of lateral veins and strengthening of the intramarginal vein from the basic brochidodromous condition is apomorphic for the eucalypt group. *Allosyncarpia* shows some proliferation of lateral venation, but retains a brochidodromous condition. The closely penniveined conditions in the bloodwood clade and in section *Transversaria* of *Symphyomyrtus* are separate further advancements.

3(1,2,3). 0 = petals not fused-calyptrate / 1 = petals fused-calyptrate. For comments see char. 4.

4(1). 0 = petals not united with calyx / 1 = petals united with calyx (L&H 4 but differently interpreted there). Free petals are undoubtably ancestral. These analyses, and general considerations, suggest that petaline calyptras have arisen repeatedly, once on the *Blakearia* + '*Corymbia* yellow' clade, several times in *Rufaria* and twice or more in the non-bloodwood eucalypt assemblage. The calyptra has hitherto been misinterpreted in *Monocalyptus*. It is clear from the condition observed by L. Johnson and B. Briggs (unpublished) in young buds of *Eucalyptus rubiginosa* Brooker, and from hybrids between *E. acmenoides* Schau. and *E. cloeziana* F. Muell. (L. Johnson & D. Blaxell unpublished) that the petaline and sepaline whorls in *Monocalyptus* are separate only at the extreme apex of the calyptra, and frequently not observable at all in mature buds. The remainder of the calyptra is a unified structure produced by intercalary growth of a ring meristem at the base of both whorls. This is similar (though almost certainly a parallel evolutionary development) to the condition in members of *'Leprolaena'* (*Eudesmia* p.p.) such as *Eucalyptus miniata* Cunn. ex Schau. Therefore the condition is scored according to this interpretation and not as 'petals absent', a misconception that has prevailed widely. This condition is clearly an apomorphy for *Monocalyptus*, and independently for parts of *'Eudesmia'* (two parts, since it is found also in *Eucalyptus jucunda* C. Gardner, which is not a *Leprolaena*, and in an unstable intermediate condition in *E. roycei* S. Carr, D. Carr & A.S. George, which shows features indicative of ultimate hybrid origin from *E. gittinsii* Brooker & Blaxell and *E. jucunda*; L. Johnson unpublished). The presence of both free (though never exposed and spreading) petals and calyptrate corollas in *Rufaria* (the red bloodwoods) suggests that the calyptrate corolla has arisen from a 'preadaptive' condition (as it clearly has arisen repeatedly in other members of the Myrtaceae; Johnson & Briggs 1984), and that several parallel acquisitions of the calyptrate state have occurred in *Corymbia*. Reversion to the free and imbricate state, especially in *Angophora*, seems highly unlikely; such a change could scarcely be simple and would be unlikely to fit into an adaptive syndrome.

5(1). 0 = adult phyllotaxis opposite / 1 = adult phyllotaxis disjunct-opposite (J&B 25, L&H 20). Opposite adult phyllotaxis is not the basic condition in the Myrtales or Myrtaceae (Johnson & Briggs 1984), but is part of an ontogenetic spectrum. In the *Arillastrum* + 'eucalypt' clade, the spiral condition has been lost (though secondarily developed in a few advanced species of *Symphyomyrtus*). The disjunct-opposite condition (simply termed disjunct in descriptions herein) is probably apomorphic, following fixation of the opposite stage and loss of the spiral condition. It seems likely that opposite phyllotaxis is basic for this clade, occurring here in the *Arillastrum* group and *Angophora*, and quite possibly basic also in the components of *Gaubaea* and of *Eudesmia*. In other eucalypt groups within the total assemblage it occurs in some species only and gives indications of being neotenous. In future analyses of the non-bloodwood groups, revised scoring of this and some other characters will be necessary, but this does not affect the *Angophora* + *Corymbia* clade. As treated here the character is labile and weak, and should not be regarded as carrying much weight. In an alternative version (Table 1b) of the data-matrix it is omitted, as possibly misleading in view of the inconstant and slight disjunction in several taxa of set (1).

[6(1). 0 = inflorescence not fixed terminal anthotelic / 1 = inflorescence fixed terminal anthotelic (L&H 5 in part, modified). The flexible condition treated here as plesiomorphic, with the ends of the flowering region variably blastotelic or anthotelic, but with anthotely of branches at least, is very clearly indicated (contrary to L&H) by inflorescence and general phylogenetic studies over the Myrtales and Myrtaceae (Briggs & Johnson 1979, Johnson & Briggs 1984). The fixed terminal anthotelic and the axillary states have arisen from this respectively after the departure of the *Angophora* + *Corymbia* clade, and other states in *Blakearia*, as well as in *Eudesmia*, *Telocalyptus* and *Gaubaea* + *Idiogenes*, are autapomorphies. Character 6 is an autapomorphy, though a significant one, for *Telocalyptus* and is hence not used in the analyses.]

7(1). 0 = inflorescence not axillary / 1 = inflorescence axillary. This is scored as 0 for all members of the *Angophora* + *Corymbia* assemblage, since terminal inflorescences occur at times throughout the groups as defined in taxon-set (1), and that condition is clearly plesiomorphic from outgroup considerations. It is not very satisfactory in the non-bloodwood assemblage either, being doubtfully scored as 1 for *'Odontocalyptus'*, and until further interpreted it should not be given too much weight in interpretation of the analyses, although the 0 state does not seem likely to be a reversion in *Telocalyptus*.

8(1). 0 = inflorescence extended / 1 = inflorescence axillary and umbellastral (not extended). Characters 7 and 8 are serial, in that condition 1 in the former is a prerequisite for condition 1 in the latter. Character 8 is omitted from the alternative data-matrix for set (1) since it is not a very well-defined condition, and seeming umbellasters may result from separate condensations of uninodate and multinodate extended inflorescences (or part thereof) (Briggs & Johnson 1984, Johnson 1972).

9(1). 0 = cotyledons entire / 1 = cotyledons emarginate (L&H 17). Entire cotyledons are the basic condition, occurring here in the *Arillastrum* group, *Angophora* and *Corymbia* (incl. *Blakearia*). They also occur in species of *Monocalyptus* that are probably close to the origins of that group, but *Idiogenes* and much of *Monocalyptus* have somewhat lobed cotyledons. *Monocalyptus* is scored here as having the emarginate state, implying reversion in some members, but this may require reconsideration.

10(1,2,3). 0 = thin-walled blunt-ended trichomes present / 1 = thin-walled blunt-ended trichomes absent (L&H 24). These occur in the *Arillastrum* group, *Angophora* and the *Corymbia* group (if branched hairs in *Arillastrum*, multicellular hairs in *Angophora* and unicellular hairs in *Corymbia* are regarded as homologous, as done by Ladiges 1984). See also characters 32 and 66. The hairs in the *Arillastrum* clade and the *Angophora* + *Corymbia* clade seem equally likely to be parallel evolutionary developments, rather than homologous (which is in agreement with J&B treatment of these hair types as independent apomorphies, J&B 19 & 20). Hairs of this type are *not* general in the Myrtales or Myrtaceae. The thicker-walled acute hairs found on oil glands in part of *Monocalyptus* are presumably apomorphic in the eucalypt group. They are similar to basic Myrtaceous hairs found as general indumentum in most other groups of the family (and some related families) but such an indumentum is absent in the *Arillastrum* + 'eucalypt' assemblage and in the *Acmena* Alliance (Johnson & Briggs 1984). In a variant scoring (Table 1b) the occurrence of thin-walled blunt-ended trichomes in some members of *Symphyomyrtus* is taken as the plesiomorphic condition for the group, suppressed ('lost') in most species (see also character 32).

11(1). 0 = bristle-glands absent / 1 = bristle-glands present (J&B 21, L&H 26). Bristle-glands are synapomorphic in the *Angophora* + *Corymbia* clade, since they do not occur elsewhere in the Myrtales, and their occurrence (universal at some ontogenetic stage) is congruent with other character-states linking these taxa.

12(1,2,3). 0 = sepals not united / 1 = sepals ± united. (L&H 1, modified by our own understanding; see discussions under characters 4 and 14). Condition 1 in character 12 is a requisite for (but does not entail) condition 1 in either character 13 or character 14.

13(1,2). 0 = sepals not united to form a calyptra shed before the corolline whorl or calyptra (i.e. either free or if united then calycine calyptra persistent) / 1 = sepals united to form a calyptra shed before the corolline whorl or calyptra.

14(1,2,3). 0 = sepals not constituting a persistent calyptra / 1 = sepaline calyptra present and persistent to anthesis. A reduced calyx of free lobes (sepals) occurs in the *Arillastrum* group, *Angophora*, *'Odontocalyptus'*, *Eudesmia* sensu stricto, *'Fibridia'* and the components of *Gaubaea*. A clear sequential order of development of apomorphic states is not evident, and the conditions are treated as three characters: 12, 13, 14 (see also character 4). The shedding and persistent calyptrate states also occur within sections and sometimes within series in *Symphyomyrtus*, where intermediate conditions can appear in hybrids. The persistent condition is clearly apomorphic in these latter cases.

15(1). 0 = ovules hemitropous or campylotropous / 1 = ovules anatropous (J&B 54, L&H 6 modified here). There is clearly homoplasy in this character in the Myrtaceae (Johnson & Briggs 1984), and it was therefore originally treated as unordered. The analysis suggests that the hemitropous condition is basic, with the anatropous condition as apomorphic in the constituents of *Gaubaea* as well as in *Idiogenes* and *Monocalyptus*, campylotropy being apomorphic in the *Arillastrum* clade. There is no homoplasy at this level, although the basic Myrtaceous condition is probably anatropous (Johnson & Briggs 1984, and references therein), suggesting that the hemitropous condition is apomorphic for the 'eucalypts'. The anatropous condition in *Monocalyptus* and *Idiogenes*, on that basis, would be a reversal, perhaps independently of a reversal or two separate reversals in the components of *Gaubaea*. Change from hemitropy to anatropy, or the reverse, is developmentally complex and should perhaps have been weighted by double scoring, as was done by Johnson and Briggs (1984).

16(1). 0 = crystalliferous layer in testa present / 1 = crystalliferous layer absent (J&B 61, L&H 10). A crystalliferous epithelium derived from the inner epidermis of the outer integument is the basic condition in Myrtaceae. Reduction is then apomorphic in *Gaubaea* and in *Idiogenes* + *Monocalyptus* (Gauba & Pryor 1958, 1959, 1961, Corner 1976).

17(1). 0 = inner integument not resorbed in seed / 1 = inner integument resorbed in seed (L&H 9). The polarity is based on outgroup considerations in the family, the order and the dicotyledons generally. The inner integument appears to be non-suberised and partly resorbed in the *Angophora* + *Corymbia* clade (Gauba & Pryor 1958,1959,1961). The inner integument is resorbed in *Arillastrum*, *Nothocalyptus*, *Telocalyptus* and *Symphyomyrtus* (Corner 1976). The inner integument is persistent and suberised in the other eucalypt groups.

18(1). 0 = outer integument 6–8 cells or 4 cells thick / 1 = outer integument 2 cells thick (L&H 11, modified here). The basic 4-celled state of the Myrtaceae (Corner 1976) requires an increase to 6–8 on the *Arillastrum* clade, and at least one separate reduction to 2 in the non-bloodwood eucalypt assemblage (clade?). An equally parsimonious explanation would be that 6–8 cells is basic, changing to 4 on the node after the *Arillastrum* group, and to 2 at the base (or bases?) of the non-bloodwood assemblage. Conditions in outgroups of the Myrtaceae will clearly be relevant to this. The zero score indicates 6–8 cells for the *Arillastrum* clade, 4 cells otherwise.

19(1). 0 = ovules not limited to 2 rows / 1 = ovules in 2 rows (L&H 7, J&B 51). Transformation from unordered to 4–10 rows is apomorphic at the base of the *Eudesmia* s. lat. clade. Further reduction to 2 rows is autapomorphic in *Monocalyptus* and, apparently separately, in '*Odontocalyptus*'; 4 rows becomes the basic state for *Symphyomyrtus*, with internal apomorphic increases to 6, 8 or 10 rows in some groups that are advanced in other characters.

20(1). 0 = stamens clustered / 1 = stamens not clustered (J&B 35, L&H 19). Drinnan & Ladiges (1988, 1989a, b, c) indicate that stamens originate (developmentally) as epipetalous fascicles in the *Eudesmia* complex, *Symphyomyrtus*, *Idiogenes* and *Monocalyptus*. The epipetaly would be apomorphic, and it certainly correlates with the occurence in those groups of the stemonophore, developed on the adaxial basal component of the corolline parts (see char. 34). It might be hypothesised that the non-fascicled androecium is a synapomorphy for the eucalypts as a whole, with secondary fasciculation occurring in the non-bloodwood assemblage and subsequently lost again in part thereof. This seems rather far-fetched (unparsimonious in the general rather than in the customary cladistic sense). Alternatively, the fasciculation on the base of the inner petal-component may be a phylogenetic continuation, with a change in position of androecial inception, of the general androecial clustered, secondarily polystemonous condition that is apparently a basic synapomorphy for the Myrtaceae sensu stricto (Johnson & Briggs 1984). In that case, continuous arrangement in the *Angophora* + *Corymbia* clade, as well as in *Gaubaea* (both components), *Telocalyptus* and apparently several members of the *Eudesmia* complex may be independent parallel changes.

21(1,2). 0 = leaves never tightly cordate, subpeltate or peltate / 1 = leaves tightly cordate, subpeltate or peltate at some stage of the juvenile-leaf succession, and sometimes neotenously also in ± adult trees (related to L&H 23, but more broadly defined). Apparently (in its weakest expression as cordate leaves such that the basal lobes of the lamina are close with a narrow sinus) an apomorphy for the *Angophora* + *Corymbia* clade. In *Angophora* and *Blakearia* it is seen only in this form, and in *Fundoria* not at all (the last case taken here to be the result of secondary loss, see below). In the other bloodwood groups further expression as actual near-peltate or peltate conditions is common, as is loss (apparently as suppression of ontogenetic stages). In taxon-sets (1) and (2) the taxa of this group are scored 1 when the character is expressed within some of their members, and also in *Fundoria*. For set (3) the relevant conditions are covered by characters 64 and 65, q.v. If the leaves are primitively never cordate to peltate in *Fundoria*, then *either* this taxon would separate earlier in the phylograms *or* it could be taken that the cordate stage in *Angophora* and the non-*Fundoria* bloodwoods arose in parallel. Loss has fairly clearly occurred within *Rufaria* and *Ochraria*, where the cordate- to peltate-leaved stages are expressed to varying degrees among the series and species.

22(1). 0 = oil-gland cap cells smooth / 1 = oil-gland cap cells ornamented (Ladiges 1984). A synapomorphy for the *Angophora* + *Corymbia* clade.

23(1). 0 = xylem vessels solitary / 1 = xylem vessels grouped (J&B 1, Ingle & Dadswell 1953). A synapomorphy for the *Angophora* + *Corymbia* clade.

24(1). 0 = paratracheal parenchyma scanty / 1 = paratracheal parenchyma confluent (J&B 9). The pattern in Myrtaceae suggests that the confluent condition is apomorphic in the *Arillastrum* Alliance and the *Angophora* + *Corymbia* clade, as well as in *Kjellbergiodendron* and the *Acmena* Alliance (Johnson & Briggs 1984).

25(1). 0 = large oil ducts in pith present or at least vestigial / 1 = large oil-ducts absent (J&B 14). Presence is scored as plesiomorphic since elongated cavities, which may be vestigial oil ducts, occur in members of the *Arillastrum* group and actual oil-ducts are recorded in *Lindsayomyrtus* and *Kjellbergiodendron* (Johnson & Briggs 1984), as well as in *Whiteodendron* (P. Wilson, pers. comm.).

26(1). 0 = inflorescence phyllotaxis disperse or flexible (disperse and opposite) / 1 = inflorescence phyllotaxis fixed opposite (J&B 27). See Briggs & Johnson 1979.

27(1). 0 = raphe of anatropous type absent / 1 = raphe of anatropous type present (Gauba & Pryor 1958, 1959, 1961). See character 35 for raphe of hemitropous type.

28(1). 0 = perianth mery not fixed (5-4) / 1 = perianth mery fixed 4 (J&B 32). See Briggs & Johnson 1979, Johnson & Briggs 1984, modified (the *Arillastrum* ('*Eucalyptopsis*') group is not fixed 5-merous as there indicated).

[29(1,2). 0 = ovary vasculature partly trans-septal / 1 = ovary vasculature axial (J&B 45). Recent further investigation of this character (Briggs & Johnson, unpublished) shows unexpected variation in some groups and it has been dropped from the analysis.]

30(1). 0 = carpels isomerous with perianth segments or not regularly fewer / 1 = carpels regularly or predominantly fewer than perianth segments (J&B 41). Independent apomorphies of reduction are indicated in the *Arillastrum* (fixed at 2 carpels only) and *Angophora* + *Corymbia* clades, as well as in some members of the non-bloodwood eucalypt assemblage.

31(1,2). 0 = stigmatic papillae long / 1 = stigmatic papillae short (Boland & Sedgley 1986). The shaggy stigma occurs in the *Arillastrum* group (at least in *Allosyncarpia*), *Angophora*, parts of *Corymbia* and parts of the non-bloodwood eucalypt assemblage. The analysis suggests that reduction of length of papillae has occurred more than once. The character has been scored here as if cases of long papillae that occur within *Monocalyptus* were reversals. *This may not be correct*, and the condition may have arisen separately in *Idiogenes* and in part of *Monocalyptus*.

32(1). 0 = radiating hairs from oil glands absent / 1 = radiating thin-walled blunt-ended hairs present on oil glands (Ladiges 1984). Outgroup comparison indicates absence as the plesiomorphic state. Simple hairs on oil glands occur in a few apparently advanced species of *Symphyomyrtus*, and in a rudimentary form in *Idiogenes*. In *Monocalyptus* hairs of a different kind (thick-walled and acute) radiate from oil glands in the stringybarks and *Eucalyptus olsenii* L.A.S. Johnson & Blaxell. Since this appears to be an independent development as an autapomorphy within *Monocalyptus*, it is not scored here. In the *Corymbia* groups simple hairs are found laterally on bristle-glands in a number of species, but the condition is apparently not basic in the group and is not scored in the general analysis. In the variant scoring used in Table 1b, *Symphyomyrtus* is scored 1 for character 32, on the alternative assumption that the condition is plesiomorphically present in that taxon and subsequently suppressed ('lost') in most of its species (see also character 10).

33(1). 0 = cap cells of protuberant oil glands 4 / 1 = cap cells of protuberant oil glands 2 (Ladiges 1984). Four cap cells occur in the *Arillastrum* group (at least in *Allosyncarpia*) and the *Angophora* + *Corymbia* clade. The analysis indicates reduction as synapomorphic in the non-bloodwood eucalypt assemblage.

34(1). 0 = stemonophore developed on corolline buttress absent / 1 = stemonophore present (Drinnan & Ladiges 1988, 1989a, b, c, 1991a, b) (see also character 4). The stemonophore is shown by Drinnan and Ladiges to be related to the development of the androecium on the corolline buttress, and it occurs in part of the non-bloodwood eucalypt assemblage, perhaps as a parallel apomorphy arising twice. If that assemblage is is in fact a clade marked by a *single* basal occurrence of this feature, then probably more than one loss (reversal) is indicated for *Gaubaea* and *Nothocalyptus* (the condition is unclear in *Telocalyptus*). *Such an interpretation would be contrary to the implications of Drinnan and Ladiges' study, and would be doubtful*, hence some review of interpretation and further developmental studies are necessary.

35(1). 0 = raphe of hemitropous type absent / 1 = raphe of hemitropous type present (Gauba & Pryor 1958, 1959, 1961). Development of a raphe is scarcely truly comparable in anatropous (*Gaubaea*, *Idiogenes*, *Monocalyptus*) and hemitropous (*Symphyomyrtus*) cases, and the anatropous case is treated separately (in contrast to the treatment by L&H) under character 27.

36(1). 0 = Fruit woody / 1 = fruit papery. The relatively unthickened fruits of *Angophora* and *Blakella* appear to be parallel autapomorphies. In any case the fruits are *not* 'unthickened' throughout *Angophora*, and although that genus is scored 1 here the woody thickening found in some species of *Angophora* may be the plesiomorphic condition. Moreover, in the *Arillastrum* clade the fruits range from strongly woody to rather thin (probably as an apomorphy in *Allosyncarpia*). In the event, the character has no effect on the topology of the trees obtained.

37(1,2). 0 = seed-coat not cracking / 1 = seed-coat cracking. The cracking seed-coat may be apomorphic for the *Angophora* + *Corymbia* clade, later showing reversal in *Rufaria* and *Blakearia*. Alternatively, it may have arisen in parallel in *Angophora* and in the 'yellow' group (*Ochraria*, *Cadagaria* and *Politaria*). Treated as unordered in the analyses.

[38(2). 0 = seeds neither laterally compressed nor terminally winged / 1 = seeds laterally compressed (usually also terminally winged). An autapomorphy for the *Rufaria* clade, not used in the analysis, though important in characterising that section.]

39(2). 0 = seed-coat reticulum regular / 1 = seed-coat reticulum partly irregular.

40(2,3). 0 = carpels (and fruit locules) 3 fixed (2 in *Arillastrum* group) / 1 = carpels 3-4 or 4. Increase in locule number may be apomorphic within *Rufaria*, and perhaps facultatively so in *Apteria*; however, the trends may be otherwise, considering the multicarpellary and often 'flexible' plesiomorphic conditions in the Myrtales and Myrtaceae (see main text 1.9.5).

41(3). 0 = carpels variably 3-4 / 1 = carpels 4 fixed.

[42(2). 0 = placental columella persistent in open fruit / 1 = columella falling. A distinct columella is present in open fruits in all of the *Angophora* + *Corymbia* clade except *Cadagaria*, where it is lost when the fruits dehisce. As an autapomorphy the character is removed from the analysis].

43(2). 0 = mesophyll fibres abundant / 1 = mesophyll fibres few.

44(2,3). 0 = all juvenile leaves petiolate / 1 = juvenile leaves sessile or subsessile at some stage.

45(2). 0 = style-tip free / 1 = style-tip engaged in calyptra.

46(2). 0 = seeds not circumferentially flanged / 1 = seeds circumferentially flanged.

[47(2). 0 = style straight / 1 = style bent in bud. Since bending of the style in *Politaria* is slight and inconstant, the state is treated as an autapomorphy for *Cadagaria*, and therefore omitted from the analysis.]

48(2,3). 0 = phloem-fibres of bark not enlarged / 1 = enlarged phloem-fibres present in bark.

49(2,3). 0 = bark decorticating at least in part / 1 = bark fully persistent, including that of small branches. The score of 1 for *Ochraria* is perhaps not correct, but it does not affect the topology of the tree obtained.

50(3). 0 = adult leaves hypostomatic / 1 = adult leaves amphistomatic.

[51(3). 0 = leaf neoteny absent / 1 = leaf neoteny in adult stage conspicuous or complete. An autapomorphy for *Rufaria* series *Ferrugineae*, so omitted from the analysis.]

52(3). 0 = seeds not winged / 1 = seeds terminally winged.

53(3). 0 = rhizomes absent / 1 = rhizomes present. Scored as present if recorded in some member of the taxon. This is not very satisfactory but, in the event, the non-zero state appears as a widely separated homoplasy not affecting the topology of the trees obtained.

54(3). 0 = flower-buds not scurfy/ 1 = flower-buds scurfy.

55(3). 0 = seeds not laterally compressed / 1 = seeds laterally compressed.

56(3). 0 = juvenile leaves (setose stage) produced through many internodes (not including neotenous conditions) / 1 = juvenile leaves not produced through many internodes.

57(3). 0 = bristle-glands absent from hypanthium / 1 = bristle-glands present on hypanthium.

58(3). 0 = underside of cotyledons red or purple / 1 = underside of cotyledons not (or scarcely) red or purple. This polarity is based on outgroup conditions.

59(3). 0 = style-base not sunken / 1 = style-base sunken. Variable in some subseries and species, constant only in *Apteria* and in *Rufaria* series *Arenariae* and scored as 1 for those taxa only. Loss of sunken style-base (J&B 49) appears to be an apomorphy for the *Arillastrum* + 'eucalypts' clade within the Myrtaceae as a whole, with reversion (and 're-emergence') in *Apteria* (and to some extent in *Fundoria*) and ± sporadically in *Rufaria*.

60(3). 0 = intramarginal vein in fully adult leaves distinct from the thickened margin (at least on abaxial surface) / 1 = intramarginal vein not clearly separated from the margin. The intramarginal vein is of course never 'absent' as indicated in some collectors' comments, and is always clearly evident microscopically in leaf transections. Although scored as 1 for *Rufaria* series *Gummiferae*, this condition is not always fully expressed therein; it does not affect the topology in the relevant part of the trees obtained.

61(3). 0 = bark not both reddish and extensively shedding / 1 = bark of reddish scales and extensively shedding.

[62(3). 0 = simple trichomes absent from bristle-glands / 1 = simple trichomes present on bristle-glands. An autapomorphy (within set (3)) for *Rufaria* series *Ferrugineae*; omitted from the analysis.]

[63(3). 0 = lenticels on fruit conspicuous / 1 = lenticels on fruit inconspicuous or absent. Further consideration shows this character to be graded within various series and even species, and it is impossible to assign values to it satisfactorily; hence it has been dropped from the analysis.]

64(3). 0 = tightly cordate, subpeltate or peltate leaf-stage not lost (includes 'Ancestor', with plesiomorphic absence) / 1 = tightly cordate, subpeltate or peltate leaf-stage secondarily suppressed or 'lost'. See discussion at character 21, especially in respect of *Fundoria*.

65(3). 0 = fully peltate leaf-stage absent / 1 = peltate leaf-stage present. See discussion at character 21. Treated as an undirected (reversible) character in the analysis.

66(2,3). 0 = hairs uniseriately multicellular or (in outgroup 'Ancestor') not as in 1 / 1 = hairs unicellular or absent. Absence of hairs (at all stages) in some *Corymbia* taxa is interpreted as secondary loss; multicellular hairs occur only in *Angophora* and the *Arillastrum* group. See discussion under character 10.

67(2,3). 0 = rough bark not tessellated / 1 = rough bark ± tessellated (or if bark all smooth then shedding in ± isodiametric flakes). This scores *Politaria* as 1 and *Fundoria* (with long-fibrous non-tessellated bark) as 0.

68(1). 0 = not host for psylloid (Hemipteran) *Glycaspis* subgenus *Glycaspis* / 1 = host for *Glycaspis* subg. *Glycaspis* (Moore 1984, 1985, 1987). This has been scored 1 for all taxa of the *Eudesmia* group as recognised here (i.e. definitely excluding both components of *Gaubaea*), though only definitely recorded for *Eudesmia* sensu stricto, *Fibridia* and *Leprolaena–Baileyanae*; these are widely separated members and the eudesmioid group has not been intensively sampled (K.M. Moore, pers. comm.). The subgenus *Glycaspis* is abundantly distributed through *Symphyomyrtus* host species, and is found on two species of *Telocalyptus*, which are not positively indicated as possessing the coralline buttresses (character 34) found in the *Eudesmia* group and *Symphyomyrtus*; it appears to be absent from *Nothocalyptus*, which has been searched extensively and which lacks the coralline buttresses. Another subgenus, *Synglycaspis*, occurs widely on *Monocalyptus*. No *Glycaspis* species, of any subgenus, have been found on members of the *Angophora* + *Corymbia* clade, which do, however, support other quite different psylloids.

Characters omitted

J&B 15. Oil ducts in petiole absent / present (? dependent on character 25).

J&B 19. Angophoroid hairs absent / present (see character 10).

J&B 20. *Arillastrum*-type hairs absent / present (see character 10).

L&H 2. Sepals persistent / shed early (not useful in these analyses and subject to confusion; see characters 4, 12, 13, 14).

L&H 3. Sepaline primordia free / fused (autapomorphic for part of *Monocalyptus* and confused; see discussion under character 4).

L&H 12. Hilum ventral / terminal (clearly developmentally associated, and completely correlated, with character 15).

L&H 13. Radicle emerging away from hilum (as for L&H 12).

L&H 18. Anthers versatile / adnate (autapomorphic separately for two parts of *Symphyomyrtus*).

L&H 21. Adult foliage developed / delayed (irregular and not necessarily homologous neoteny throughout).

L&H 25. Thick-walled, acute-ended hairs absent / present (see character 32).

Apomorphies for *Arillastrum* + 'eucalypts' (not used in analysis and not all confined to the *Arillastrum* + 'eucalypts' clade)

1. Vessel ray pits small > large (J&B 4).
2. Myrtaceous hairs present > absent (J&B 16).
3. Stipules present > absent (J&B 23).
4. Phyllotaxis disperse > fixed opposite (including disjunct) (J&B 25).
5. Inflorescence recaulescence present > lost (J&B 30) (perhaps secondarily 're-emergent' in part of *Blakearia*, q.v.).
6. Ovulodes absent > present (J&B 55, L&H 8).
7. Embryo straight > folded (J&B 63, L&H 14).
8. Cotyledons not deflexed > deflexed (L&H 15).

Apomorphies for *Arillastrum* group (not used in the analyses)

1. Branched multicellular hairs (J&B 20)
2. Reduced anthopodia (J&B 31).
3. Carpel number reduced to 2 (J&B 41).
4. Stone-cells in petals (L&H 27).

		111	11111	11222	22222	23333	33336
	23457	89012	34567	89012	34567	80123	45678
Ancestor	00000	00000	00000	00000	00000	00000	00000
Arillastrum group	00000	00000	00001	00000	01000	01000	00000
Odontocarpae	11001	11000	00000	01100	00110	11111	10001
Eudesmia s. str.	11001	11000	00000	00000	00110	11111	10001
Fibridia	11001	11000	00000	00000	00110	11111	10001
Leprolaena Baileyanae	11111	11001	01000	00000	00110	11111	10001
Leprolaena Miniatae	11111	11001	01000	00100	00110	11111	10001
Symphyomyrtus	11011	01101	10001	10100	00110	10101	11001
Nothocalyptus	10011	11100	00001	10000	00110	10001	01000
Telocalyptus	11010	01100	00001	10100	00110	10001	01001
Gaubaea (Gauberwinia)	10001	11100	00110	00100	00111	10001	00000
Idiogenes	11011	01100	00110	00100	00111	10101	10000
Monocalyptus	11111	11101	10110	01100	00111	10101	10000
Angophora	10000	00010	00000	00111	11010	01000	00110
Corymbia Fundoria	10010	00011	01000	00111	11010	01000	00000
Corymbia Apteria	10010	00011	01000	00111	11010	01000	00000
Corymbia Rufaria	10010	00011	01000	00111	11010	01000	00000
Corymbia 'yellow'	11011	00011	10000	00111	11010	01100	00010
Corymbia Blakearia	11011	00011	10000	00111	11010	01100	00100

Table 1a. Data matrix 'a' used in the cladistic analysis of the *Arillastrum*–eucalypt set (character numbers as in Appendix 2).

		11111	11111	22222	22223	33333	336
	23479	01234	56789	01234	56780	12345	678
Ancestor	00000	00000	00000	00000	00000	00000	000
Arillastrum group	00000	00000	00100	00001	00001	00000	000
Odontocarpae	11011	00000	00001	10000	11011	11110	001
Eudesmia s. str.	11011	00000	00000	00000	11011	11110	001
Fibridia	11011	00000	00000	00000	11011	11110	001
Leprolaena Baileyanae	11111	00101	00000	00000	11011	11110	001
Leprolaena Miniatae	11111	00101	00000	10000	11011	11110	001
Symphyomyrtus	11011	00110	00110	10000	11010	11111	001
Nothocalyptus	10011	10000	00110	00000	11010	00101	000
Telocalyptus	11001	10000	00110	10000	11010	00101	001
Gaubaea (Gauberwinia)	10011	10000	11000	10000	11110	00100	000
Idiogenes	11011	10000	11000	10000	11110	10110	000
Monocalyptus	11111	10110	11001	10000	11110	10110	000
Angophora	10000	01000	00000	11111	01001	00000	110
Corymbia Fundoria	10000	01101	00000	11111	01001	00000	000
Corymbia Apteria	10000	01101	00000	11111	01001	00000	000
Corymbia Rufaria	10000	01101	00000	11111	01001	00000	000
Corymbia 'yellow'	11010	01110	00000	11111	01001	10000	010
Corymbia Blakearia	11010	01110	00000	11111	01001	10000	100

Table 1b. Matrix 'b': differs from matrix 'a' only in the the omission of characters 5 and 8, and in that character 10 is scored as absent (state 0) while character 32 is scored as present (state 1) for *Symphyomyrtus*; see discussion of the relevant characters.

	1111	**2333**	**44444**	**44**
	30234	**1179**	**03456**	**89**
Ancestor	00000	0000	00000	00
Angophora	00000	0010	00101	00
Fundoria	00101	0001	00100	01
Apteria	00101	1001	10000	10
Rufaria	10101	1001	10000	10
Ochraria	10110	1110	01010	11
Cadagaria	11110	1110	01000	00
Politaria	11101	1110	01000	00
Blakearia	10110	0100	01111	00

Table 2. Data matrix used in the cladistic analysis of the *Angophora*–bloodwood set (character numbers as in Appendix 2).

	1114	**44445**	**55555**	**55566**	**6666**
	30240	**14890**	**23456**	**78901**	**4567**
Ancestor	00000	00000	00000	00000	0000
Angophora	00000	01000	00000	10000	0000
Rufaria Fundoria	00110	01010	01000	00000	1010
Ruf Apteria	00111	00100	01000	00100	0111
Ruf Gummiferae	00111	00100	00011	00010	0111
Ruf Nesophilae	10111	00100	10010	00000	0111
Ruf Ficifoliae	01111	10100	10011	00000	0011
Ruf Abergianae	11111	10100	10111	00000	0011
Ruf Intermediae	00111	10110	10011	01000	0011
Ruf Ptychocarpae	11111	10110	11111	01000	0011
Ruf Polycarpae	11111	10110	10111	01000	1011
Ruf Porrectae	11111	10111	11011	01000	1011
Ruf Rhodopes	10111	11100	10010	00000	0011
Ruf Arenariae	00111	10100	10010	00100	0011
Ruf Collinae	10111	10101	10010	01001	0011
Ruf Oocarposae	10111	10101	10011	01001	0011
Ruf Dichromophloiosae	10111	10101	11011	01011	1011
Ruf Terminalosae	11111	10101	10111	01011	1011
Ruf Latifoliosae	11111	10101	10111	01011	1011
Ruf Cliftonianae	10111	10101	10010	01010	0011
Ruf Ferrugineae	10111	10111	10010	11000	0011

Table 3. Data matrix used in the cladistic analysis of the augmented red bloodwoods (character numbers as in Appendix 2).

Appendix 3. A classification of the genus *Corymbia* (codes as explained in sect. 1.12)

Section	Series	Subseries	Species	Subspecies	Superspecies
ACA Fundoria	ACAJ (Jacobsianae)	—	ACAJJA Corymbia jacobsiana		
ACE Apteria	ACET (Trachyphloiae)	—	ACETTA Corymbia trachyphloia	ACETTAH subsp. trachyphloia	
				ACETTAM subsp. amphistomatica	
				ACETTAV subsp. carnarvonica	
ACI Rufaria	ACIB Gummiferae	—	ACIBBA Corymbia gummifera		
			ACIBBE Corymbia haematoxylon		} Superspecies
			ACIBBL Corymbia chlorolampra		} Haematoxylon
			ACIBBY Corymbia calophylla		
	ACID Nesophilae	—	ACIDDN Corymbia nesophila		
	ACIE Abergianae	—	ACIEEA Corymbia abergiana		
	ACIF Ficifoliae	—	ACIFFI Corymbia ficifolia		
	ACIG Intermediae	—	ACIGGI Corymbia intermedia		
	ACIJ Ptychocarpae	—	ACIJJO Corymbia ptychocarpa	ACIJJOP subsp. ptychocarpa	
				ACIJJOY subsp. aptycha	
	ACIL Polycarpae	—	ACILLA Corymbia polycarpa		}
			ACILLD Corymbia novoguinensis		}
			ACILLE Corymbia clarksoniana		}
			ACILLJ Corymbia maritima		}
			ACILLK Corymbia ligans	ACILLKL subsp. ligans	} Superspecies
				ACILLKM subsp. burdekinensis	} Polycarpa
				ACILLKN subsp. novocastrensis	}
			ACILLO Corymbia dolichocarpa		}
			ACILLP Corymbia plena		}
	ACIN Porrectae	—	ACINNO Corymbia porrecta		
	ACIQ Arenariae	—	ACIQQI Corymbia arnhemensis	ACIQQIA subsp. arnhemensis	
				ACIQQIM subsp. monticola	
			ACIQQU Corymbia arenaria		
	ACIR Rhodopes	ACIRA Rhodoposae	ACIRAR Corymbia rhodops		
		ACIRB Brachycarposae	ACIRBA Corymbia xanthope		} Superspecies
			ACIRBE Corymbia hendersonii		} Xanthope
			ACIRBY Corymbia brachycarpa		} Superspecies
			ACIRBZ Corymbia clandestina		} Brachycarpa

Appendix 3. A classification of the genus *Corymbia* (cont.)

Section	Series	Subseries	Species	Subspecies	Superspecies
		ACIRS Stockerianosae	ACIRSH Corymbia hylandii	ACIRSHI subsp. hylandii	
				ACIRSHP subsp. peninsularis	
			ACIRSK Corymbia stockeri		
			ACIRSL Corymbia lamprophylla		
	ACIS Collinae	—	ACISSB Corymbia bleeseri		
			ACISSO Corymbia collina		
	ACIV Dichromophloiae	ACIVB Oocarposae	ACIVBO Corymbia oocarpa		
		ACIVE Dichromophloiosae	ACIVEA Corymbia dichromophloia		
			ACIVED Corymbia drysdalensis		} Superspecies
			ACIVEF Corymbia capricornia		} Capricornia
			ACIVEJ Corymbia umbonata		} Superspecies
			ACIVEK Corymbia rubens		} Umbonata
			ACIVEP Corymbia pocillum		}
			ACIVER Corymbia erythrophloia		} Superspecies
			ACIVES Corymbia ellipsoidea		} Erythrophloia
			ACIVET Corymbia porphyritica		}
		ACIVI Terminalosae	ACIVIB Corymbia eremaea	ACIVIBE subsp. eremaea	} Superspecies
				ACIVIBF subsp. oligocarpa	} Eremaea
			ACIVIG Corymbia lenziana		}
			ACIVIJ Corymbia chippendalei		
			ACIVIL Corymbia hamersleyana		}
			ACIVIM Corymbia semiclara		}
			ACIVIO Corymbia opaca		} Superspecies
			ACIVIS Corymbia tumescens		} Terminalis
			ACIVIT Corymbia terminalis		}
		ACIVJ Intersubserial hybridogenous species (Dichromophloiosae – Terminalosae)			
			ACIVJO Corymbia opacula		
		ACIVO Latifoliosae	ACIVOA Corymbia latifolia		
			ACIVOD Corymbia dampieri		}
			ACIVOE Corymbia greeniana		}
			ACIVOG Corymbia byrnesii		} Superspecies
			ACIVOK Corymbia curtipes		} Foelscheana
			ACIVOL Corymbia foelscheana		}
		ACIVR Intersubserial hybridogenous species (Terminalosae – Latifoliosae)	ACIVRI Corymbia pedimontana		

Appendix 3. A classification of the genus *Corymbia* (cont.)

Section	Series	Subseries	Species	Subspecies	Superspecies
	ACIW Cliftonianae	—	ACIWWK Corymbia cliftoniana		
	ACIX Ferrugineae	ACIXA Ferrugineosae	ACIXAE Corymbia ferruginea	ACIXAEF subsp. ferruginea	
				ACIXAEK subsp. stypophylla	
			ACIXAV Corymbia abbreviata		
		ACIXE Cadophorosae	ACIXEC Corymbia cadophora	ACIXECA subsp. cadophora	
				ACIXECI subsp. pliantha	
		ACIXO Zygophyllosae	ACIXOA Corymbia zygophylla		} Superspecies
			ACIXOE Corymbia sphaerica		} Zygophylla
			ACIXOJ Corymbia chartacea		} Superspecies
			ACIXOL Corymbia dunlopiana		} Chartacea
			ACIXOS Corymbia setosa	ACIXOSE subsp. setosa	}
				ACIXOSP subsp. pedicellaris	} Superspecies
			ACIXOY Corymbia pachycarpa	ACIXOYA subsp. pachycarpa	} Setosa
				ACIXOYG subsp. glabrescens	}
		ACIXU Deserticolosae			
			ACIXUA Corymbia papillosa	ACIXUAP subsp. papillosa	
				ACIXUAX subsp. globifera	
			ACIXUD Corymbia deserticola	ACIXUDE subsp. deserticola	
				ACIXUDM subsp. mesogeotica	
ACO Ochraria	ACOY (Eximiae)	—	ACOYYA Corymbia leptoloma		
			ACOYYC Corymbia leichhardtii		
			ACOYYE Corymbia bloxsomei		
			ACOYYG Corymbia bunites		
			ACOYYJ Corymbia aureola		
			ACOYYL Corymbia petalophylla		
			ACOYYN Corymbia catenaria		
			ACOYYO Corymbia watsoniana	ACOYYOB subsp. watsoniana	
				ACOYYOC subsp. capillata	
			ACOYYQ Corymbia dimorpha		
			ACOYYR Corymbia peltata		
			ACOYYS Corymbia scabrida		
			ACOYYX Corymbia eximia		
ACQ Cadagaria	ACQU (Torellianae)	—	ACQUUT Corymbia torelliana		
ACS Politaria	ACSA (Maculatae)	—	ACSAAC Corymbia citriodora		} Superspecies
			ACSAAL Corymbia variegata		} Maculata
			ACSAAS Corymbia maculata		}
			ACSAAX Corymbia henryi		

Appendix 3. A classification of the genus *Corymbia* (cont.)

Section	Series	Subseries	Species	Subspecies	Superspecies
ACU Blakearia	ACUA Tessellares	—	ACUAAT Corymbia tessellaris		
	ACUC Papuanae	—	ACUCCE Corymbia papuana		}
			ACUCCF Corymbia paracolpica		} Superspecies
			ACUCCJ Corymbia arafurica		} Papuana
			ACUCCL Corymbia bella		}
	ACUD Clavigerae	—	ACUDDL Corymbia clavigera		
	ACUF Kombolgienses	—	ACUFFK Corymbia kombolgiensis		
	ACUH Polysciadae	—	ACUHHA Corymbia polysciada		
			ACUHHI Corymbia torta	ACUHHIC subsp. torta	
				ACUHHIJ subsp. allanii	
				ACUHHIM subsp. mixtifolia	
	ACUII Confertiflorae	—	ACUIIA Corymbia disjuncta		
			ACUIIB Corymbia pauciseta		
			ACUIIC Corymbia confertiflora		
			ACUIIE Corymbia karelgica		
			ACUIIF Corymbia dendromerinx		
	ACUK Gilbertenses	—	ACUKKA Corymbia chillagoensis		}
			ACUKKG Corymbia gilbertensis		}
			ACUKKI Corymbia inobvia		} Superspecies
			ACUKKO Corymbia blakei	ACUKKOB subsp. blakei	} Gilbertensis
				ACUKKOR subsp. rasilis	}
	ACUL Asperae	—	ACULLC Corymbia candida	ACULLCA subsp. candida	
				ACULLCL subsp. lautifolia	
				ACULLCS subsp. dipsodes	
			ACULLF Corymbia ferriticola	ACULLFE subsp. ferriticola	
				ACULLFS subsp. sitiens	
			ACULLI Corymbia aspera		} Superspecies
			ACULLP Corymbia punkapitiensis		} Aspera
	ACUS Grandifoliae	—	ACUSSD Corymbia dallachiana		} Superspecies
			ACUSSI Corymbia aparrerinja		} Aparrerinja
			ACUSSL Corymbia flavescens		
			ACUSSO Corymbia grandifolia	ACUSSOG subsp. grandifolia	
				ACUSSOL subsp. longa	
				ACUSSOP subsp. lamprocardia	
	ACUT Interserial hybridogenous species (Confertiflorae – Grandifoliae)				
		—	ACUTTO Corymbia paractia		

Appendix 4. Usage correspondence table for Brooker & Kleinig (1994)

A recent semi-popular handbook (Brooker & Kleinig 1994) to eucalypts (not including *Angophora* species) of northern Australia, which includes excellent colour photographs, adopts usages and circumscriptions of species that often differ to a greater or lesser degree from those resulting from the present study. Since submission of this paper we have been compelled, for formal reasons of priority of synonymisation, to take up the epithet *umbonata* in place of *ollaris* (see under *Corymbia umbonata*) as a result of the Brooker & Kleinig publication, but we have found no necessity or good reason to make any further changes. Our concepts of genera and species are explained in the earlier parts of this paper, and are based on wide experience in many plant groups and on theoretical considerations, as well as field experience of all but one species and two subspecies, supplemented by careful study in the herbarium and nursery. These lead us to recommend the classification and usage herein.

Accordingly, this appendix provides a listing, with brief comments where necessary, of the Brooker & Kleinig [B&K] usage with cross-reference to that of the present work [H&J]. It should be noted that several species treated in H&J are not covered at all in B&K, although some occur in 'northern Australia'; these northern species are: *C. claudestina*, *C. rubens*, *C. opacula*, *C. pedimontana*, *C. catenaria* (virtually not covered), *C. torta* (3 subspecies), *C. chillagoensis* (unless implicitly included in B&K's concept of *Eucalyptus confertiflora*), *C. inobvia*, *C. blakei* (2 subspecies), *C. punkapitiensis* and *C. paractia*.

Brooker & Kleinig	**Hill & Johnson**	**Comments**
Eucalyptus subgenus *Blakella*	*Corymbia* section *Blakearia*	
E. tessellaris	*C. tessellaris*	
E. sp. AA	*C. arafurica* and *C. bella*	B&K map omits Normanton area in SE (see H&J maps). We know of no 'intergrades' with *C. tessellaris.*
E. papuana var. *papuana*	*C. papuana* (N. Guin.) and *C. paracolpica* (Qld)	B&K map incomplete for *C. paracolpica.*
E. polysciada	*C. polysciada*	B&K map incomplete.
E. confertiflora	*C. disjuncta*, *C. pauciseta*, *C. confertiflora*, *C. karelgica* and *C. dendromerinx*	B&K map composite and New Guinea (*C. disjuncta* in part) not mentioned.
E. kombolgiensis	*C. kombolgiensis*	B&K map omits islands of Gulf of Carpentaria.
E. sp. BB	*C. flavescens* in part, *C. grandifolia* in part and *C. candida* x *C. flavescens*	B&K map misleading.
E. papuana var. *aparrerinja*	*C. aparrerinja* in part	The name as used by B&K is invalid; their map incomplete in N & NE.
E. tessellaris var. *dallachyana*	*C. dallachiana*, *C. flavescens* and *C. aparrerinja* in part	The epithet is misspelt by B&K; their map is incorrect in part; no member of this group is in W Cape York P.; see H&J maps.

Brooker & Kleinig	Hill & Johnson	Comments
E. grandifolia	*C. grandifolia* in part (3 subspecies, in part)	B&K map for sp. BB also applies to *C. grandifolia* in part.
E. gilbertensis	*C. gilbertensis*	
E. aspera	*C. aspera* and *C. candida* (3 subspp.) in part	B&K concepts and map mixed; see H&J text and maps.
E. ferriticola	*C. ferriticola* subsp. *ferriticola* in part	Apparently some confusion in B&K with *C. candida*; their map shows '*ferriticola*' too far NW and not far enough SE.
E. sp. CC	*C. ferriticola* subsp.*sitiens* and subsp.*ferriticola* in part, *C. candida* subsp. *dipsodes* in part, and hybrids of that with *C. aparrerinja*	B&K's map is puzzling in part, but their concept mainly fits *C. ferriticola* subsp. *sitiens*, for which their appellation 'Desert ghost gum' is suitable.
Eucalyptus subgenus *Corymbia*	All sections of *Corymbia* except *Blakearia*	See H&J text on the reasons for rejecting this concept.
[*E.*] section *Rufaria*	*C.* sect. *Rufaria*	
E. gummifera	*C. gummifera*	
E. lamprophylla	*C. lamprophylla*	
E. intermedia	*C. intermedia*	B&K map shows an area in NE Cape York Peninsula, from which we have no authentic record of this species.
E. xanthope	*C. xanthope*	
E. clarksoniana	*C. novoguinensis*, *C. clarksoniana*, *C. maritima*, *C. ligans* and *C. dolichocarpa*	If these species were to be united it would be illogical not to include them all, with *C. plena*, in a broad concept of *C. polycarpa*. See H&J maps.
E. polycarpa	*C. polycarpa*	
E. sp. DD	*C. plena*	B&K map area too narrow (see H&J map).
E. stockeri	*C. stockeri* and *C. hylandii* subsp. *peninsularis*	B&K map area includes both taxa and part of *C. hylandii* subsp. *hylandii* as well (see H&J maps).
E. hylandii	*C. hylandii* subsp. *hylandii*	B&K map incomplete (see H&J map). *C. hylandii* is not 'related to *E. clarksoniana*' as stated by B&K.
E. brachycarpa	*C. brachycarpa*	B&K map incomplete (see H&J map).
E. serendipita	*C. arnhemensis* subsp. *monticola*, *C. ligans* subsp. *novocastrensis* in part, *C. porphyritica* in part, and perhaps *C. pocillum* in part	See H&J main text under *C. arnhemensis* subsp. *monticola*. B&K habit photo not *C. arnhemensis* but may be *C. pocillum*.

Appendix 4. Usage correspondence table (cont.)

Brooker & Kleinig	Hill & Johnson	Comments
E. arnhemensis	*C. arnhemensis* subsp. *arnhemensis*	
E. arenaria	*C. arenaria*	
E. sp. EE	*C. hendersonii*	
E. abergiana	*C. abergiana*	
E. rhodops	*C. rhodops*	
E. ptychocarpa	*C. ptychocarpa* (2 subspecies)	
E. nesophila	*C. nesophila*	
E. bleeseri	*C. bleeseri*	
E. collina	*C. collina*	
E. oocarpa	*C. oocarpa*	
E. atrovirens	*C. dichromophloia* in part	See H&J text under *C. dichromophloia.*
E. dichromophloia	*C. dichromophloia* in part, *C. drysdalensis* in part and *C. capricornia*	B&K map incomplete for *C. drysdalensis.* (see H&J maps and text).
E. drysdalensis	*C. drysdalensis* in part	B&K map incomplete. (See H&J maps and text.
E. umbonata	*C. umbonata*	See H&J text on synonymy.
E. erythrophloia	*C. erythrophloia,* *C. porphyritica* and *C. pocillum*	See H&J text and maps for clarification.
E. cliftoniana	*C. cliftoniana*	B&K map omits west of area (see H&J map).
E. lenziana	*C. lenziana* and *C. eremaea* subsp. *eremaea* in part	B&K map in NE includes part of area of *C.eremaea* subsp. *eremaea*, to which *E. symonii* is referred by H&J (not to *C. lenziana*, as by B&K); see H&J map.
E. eremaea	*C. eremaea* (2 subspecies) in major part	See note under *C. lenziana*.
E. terminalis	*C. terminalis,* *C. opaca,* *C. tumescens* and *C. semiclara*	B&K map area extends well N of that of any of these species (see H&J maps). B&K state that from their 'extensive recent field studies' [they] 'are satisfied that *E. terminalis* cannot be satisfactorily subdivided'; however, allowing for restricted intergradation, and from our extensive field and herbarium studies, it is manifestly divisible (see H&J text). The B&K habit photo is of *C. opaca*.

Brooker & Kleinig	Hill & Johnson	Comments
E. chippendalei	*C. chippendalei*	The B&K photos show redder bark than is characteristic.
E. hamersleyana	*C. hamersleyana* and probably *C. semiclara* (in part)	The B&K photos may represent *C. semiclara* or an intergrade.
E. dampieri	*C. dampieri*	We do not know of this species as far E as 'about Mt House'.
E. latifolia	*C. latifolia*	B&K omit the N Qld and New Guinea areas. See H&J map and text.
E. foelscheana	*C. foelscheana*	
E. greeniana	*C. greeniana*, *C. curtipes* and *C. byrnesii*	B&K map is composite; see H&J map and text. *E. tokwa*, cited by B&K in synonymy, has nothing to do with *C. greeniana*, and is a hybrid from New Guinea (see H&J text).
E. porrecta	*C. porrecta*	
E. ferruginea	*C. ferruginea* (2 subspecies)	
E. abbreviata	*C. abbreviata*	
E. sp. FF	*C. dunlopiana*	
E. setosa	*C. setosa* (2 subspecies)	B&K map needs slight change (see H&J map).
E. sp. GG	*C. papillosa* (2 subspecies)	B&K map omits WA area of subsp. *globifera* (see B&H).
E. deserticola	*C. deserticola* (2 subspecies)	B&K map omits E part of subsp. *mesogeotica* (see H&J map).
E. sp. HH	Presumably hybrid(s), information insufficient.	'[P]etiolate, longer leaves' [than in *C. deserticola*] and B&K's photo showing smooth outer branches and the spotty occurrence point to members of *Dichromophloiae* and *Ferrugineae* (but not *C. deserticola*, from the localities) as parents of sporadic hybrids. B&K's habit photo shows a tree, not a 'mallee'.
E. sp. II	*C. sphaerica*	
E. sp. JJ	*C. chartacea*	B&K's map area needs some extension to the S (see H&J map).
E. sp. KK	*C. pachycarpa* subsp. *pachycarpa*	B&K map omits area of subsp. *glabrescens* (see H&J map).
E. zygophylla	*C. zygophylla*	
E. sp. LL	*C. cadophora* (2 subspecies)	

Appendix 4. Usage correspondence table (cont.)

Brooker & Kleinig	Hill & Johnson	Comments
[*E.*] section *Ochraria*	*C.* section *Ochraria*	
E. peltata subsp. *peltata*	*C. peltata*	
E. peltata subsp. *dimorpha*	*C. dimorpha*	
E. scabrida	*C. scabrida*	
E. leichhardtii	*C. leichhardtii* and *C. catenaria* in part	Minor part only of B&K map covers *C. catenaria.*
E. bunites	*C. bunites*	
E. watsoniana subsp. *watsoniana*	*C. watsoniana* subsp. *watsoniana*	
E. watsoniana subsp. *capillata*	*C. watsoniana* subsp. *capillata* and perhaps *C. catenaria* in part	B&K map area does not include *C. catenaria.*
E. petalophylla	*C. petalophylla*	
E. bloxsomei	*C. bloxsomei*	
E. aureola	*C. aureola*	
E. leptoloma	*C. leptoloma*	
[*E.*] *Trachyphloiae*	*C.* sect. *Apteria*	
E. trachyphloia	*C. trachyphloia* (3 subspecies)	
[*E.*] *Torellianae*	*C.* sect. *Cadagaria*	
E. torelliana	*C. torelliana*	
[*E.*] *Jacobsianae*	*C.* sect. *Fundoria*	
E. jacobsiana	*C. jacobsiana*	
[*E.*] sect. *Maculatae*	*C.* sect. *Politaria*	
E. maculata	*C. maculata* and *C. variegata*	Only *C. variegata* in B&K's map area.
E. henryi	*C. henryi*	
E. citriodora	*C. citriodora*	

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New names and combinations are printed in boldface; synonyms are printed in *italics*.